POLITICAL ECONOMY OF ENVIRONMENTAL DISASTERS AND VOLUNTARY APPROACHES IN ENVIRONMENTAL POLICY

by

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DISSERTATION ABSTRACT

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Title: Political Economy of Environmental Disasters and Voluntary Approaches in Environmental Policy

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In Chapter II I analyze eco-labeling in the tourism industry, specifically the impact of the Blue Flag label for marinas and beaches on prices of marina slip rentals, weekly sailboat charter prices and hotel accommodation prices. The principal findings include that Blue Flag certified marinas appear to enjoy an average premium between 6.6% and 22% for their daily slip rental prices, between 40% and 49% for their monthly slip rental prices, and 23% for their yearly slip rental prices. Within the sailboat charter sector, vessels whose home marina is awarded the Blue Flag on average carry a price premium between 14% and 20% on a weekly sailboat rental. When it comes to hotel accommodation, hotels managing a Blue Flag certified beach enjoy a price premium between 45% and 270%.

In Chapter III I employ a dataset on the global frequency of climate-change-related natural disasters to explain the probability of the start and occurrence, in a given year, of civil war and civil war durations during the last half of the 20th century. Extreme cold events are found to have a measurable positive effect on the probability of civil war starting in the affected countries, previous years' extreme heat events have a positive

effect on the probability of a civil war occurring in a given year, and droughts have a positive effect on civil war duration. These findings can be used by policymakers as they contemplate climate change mitigation policies.

In Chapter IV I investigate the determinants of ratification delay of a major oil pollution international environmental agreement, MARPOL. Importantly, I analyze the impact of oil spills, as well as various country characteristics, on the time a country takes to ratify MARPOL. The major contribution lies in the examination of impacts of environmental pollution events on international political decision making. I find that the amount of oil spilled decreases the time to ratify MARPOL. This is the first study that seeks to address this issue in a quantitative fashion. The results should inform policymakers by giving them insight into relevant determinants of legislative delay in ratifying treaties.

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CHAPTER I

INTRODUCTION

This dissertation is concerned with two general themes: voluntary approaches in environmental policy and the political economy of environmental disasters. In Chapter II I focus on eco-labeling as a voluntary approach that has become a popular alternative to regulation as means of dealing with various environmental issues. Eco-labeling provides consumers with information on environmental impact of their consumption. This allows consumers to differentiate goods and services based on their respective environmental attributes. This, in turn, allows producers to attach a price premium to a certified product. Such a premium provides an additional incentive for producers to meet certification standards, leading to an improvement in environmental performance of certified products. In this chapter I specifically focus on the issue of the price premium. Previous research has identified cases where such a premium exists and ones where it doesn't. Without the existence of the price premium, eco-labeling would be an ineffective policy as it would not incentivize producers to improve the environmental impact of their production. Thus, to answer this question is to evaluate a specific eco-labeling policy.

In Chapter II I specifically analyze the effects of eco-labeling in service industries, expanding the scope of the existing literature focusing primarily on goods industries. The study concerns eco-labeling in the tourism industry, specifically the impact of the Blue Flag label for marinas and beaches on prices of marina slip rental prices, weekly sailboat charter prices and hotel accommodation prices. This study's findings suggest that Blue Flag certification of marinas is associated with a significant price premium in the market for marina slip-rental prices and sailboat charters. Similarly, the Blue Flag beach certification is found to be associated with a price premium in the hotel industry.

In addition to identifying a price premium associated with a specific eco-label in three distinct sectors of the tourism industry, this chapter contributes to the literature in voluntary approaches to environmental policy in two other ways. First, I employ an empirical strategy that deals with the problem of program selection. Most previous research suffers from endogeneity bias, and this chapter of the dissertation addresses this issue head on. Secondly, it looks at the impact of an eco-label in a service industry. Great majority of previous work focuses on goods, leaving a major gap in knowledge, which this chapter addresses by focusing on three service industries.

Chapter III and IV focus on the political economy of natural disasters. Specifically, Chapter III looks at the impact of climate-change related natural disasters on several measures of civil war. Chapter IV proposes to study the impact of man-made environmental disasters, in this case oil pollution in the oceans, on the length of ratification of a major marine pollution international environmental agreement. The impact of disasters on political decision making is seldom studied. However, anecdotal evidence suggests that it can be a major determinant of various measures of political decisions.

In the case of environmental policy, an environmental disaster raises the awareness about the true costs of such events. This, in turn, increases the demand by the public for policies that deal with prevention and adaptation to such events. Governments respond by enacting laws that address the issue. Famous examples are the Love Canal incident and the passage of Superfund legislation, and Exxon Valdez oil spill and the national oil spill liability law, to name a few. In Chapter III I study how environmental disaster s affect the probability of civil war starting and continuing. Disasters primarily affect people's willingness to pursue violent conflict to pursue political goals. Specifically, it is hypothesized that disasters that affect people's incomes, also affect individual opportunity costs of fighting.

Chapter III I examine the effect of climate change on violent conflict. This chapter employs a dataset on the global frequency of climate-change- related natural disasters to explain the probability of the start and occurrence, in a given year, of civil war, and duration, during the last half of the 20th century. Extreme cold events and epidemic outbreaks are found to have a measurable positive effect on the probability of civil war starting in the affected countries; previous years extreme heat events have a positive effect on the probability of a civil war occurring in a given year; and droughts have a positive effect on civil war duration. These findings can be used by as they contemplate climate change mitigating policies.

In Chapter IV I use continuous-time hazards model framework to investigate the impact of oil spills, as well as various country characteristics, on the duration of time taken to ratify the international environmental agreement on marine pollution called MARPOL. This is a first study that seeks to address this issue in a quantitative fashion. The results can inform policy makers by giving them insight into relevant determinants of legislative delay of this treaty

CHAPTER II

ECO-LABELING OF SERVICES: THE BLUE FLAG

2.1. Introduction

Environmental or eco-labeling has recently received attention as an alternative to command and control regulations as means of relieving consumption and production pressures on the environment. Eco-labeling informs consumers about the environmental effects of their consumption decisions. The desired effect is a change in consumption patterns toward more environmentally friendly products, as well as the creation of incentives for firms to produce such goods and services. Moreover, such practices are often intended to encourage governments in setting environmental standards for products and services.

The literature has explored the effectiveness of eco-labels to achieve these goals in various settings. However, most of these studies have focused on the labeling of tangible goods. Extension of the idea to services does not seem to have been addressed in the literature. Given the ever-increasing share of services in the economy, this analysis aims to fill the gap in the literature by identifying the determinants of price premia associated with eco-labeling in service industries.

To illustrate eco-labeling in service industries, I use an example concerning the “sun-and-beach” sector of the tourism industry in Croatia. This segment of the industry is inextricably tied to the environment where leisure and recreational activities take place, and it can be presumed that environmental quality is of positive value to the individuals who consume these activities. Thus, a region endowed with a relatively cleaner environment is more likely to attract such consumers, *ceteris paribus*. Moreover, when businesses in a region are also proactive about protecting the environment, maintaining certain standards to insure environmental quality, then that region is also likely to attract environmentally conscious consumers. However, prospective consumers may not have enough information to gauge the difference in environmental quality between alternate destinations.

To bridge the information gap between consumers and providers of services, labeling or certification schemes are often provided by an independent organization. In the case of marinas and beaches, which are pivotal components of sun-and-beach tourism recreation, this information is supplied by the Blue Flag certification. Thus, the presence of certified marinas and beaches in the region should influence the prices of the tourism services in this sector, including marina slip-rental prices, sailboat charter prices and hotel room prices.

The Blue Flag certification is displayed by awarded sites with a flag hoisted on a pole. Thus anyone passing by the certified site is clearly informed about its certification status. Each site also displays information regarding environmental programs pursued in accordance with the certification on a publicly displayed board. Hotel, marina and sailboat charter companies prominently display their Blue Flag certification status on all promotional materials including brochures and websites.

The Blue Flag environmental label was started in France in 1985 as a label awarded to environmentally minded local governments. In 1987 the program became a part of the Foundation for Environmental Education in Europe (FEEE), non-governmental (NGO), non-profit organization promoting sustainable development through environmental education. The program was then extended to beaches and marinas across Europe. Some 244 beaches and 208 marinas from 10 countries have been awarded the Blue Flag (The Blue Flag, 2007). With the growth in participation came the standardization of criteria. In 1992 the program started using stricter criteria set by the EEC Bathing Water Directive. In 2001 FEEE decided to expand its reach beyond Europe to become the global organization Foundation for Environmental Education (FEE). FEE is an international umbrella organization with one national member organization per country which represents FEE on the national level and manages the implementation of FEE programs nationally. FEE has member organizations in 48 countries in Europe, North and South America, Africa, Asia and Oceania. It is active through five environmental education and labeling programs: Blue Flag, Eco-Schools, Young Reporters for the Environment, Learning about Forests and Green Key. Since 2001, FEE has worked with the World Trade Organization and other international institutions on the expansion of the Blue Flag program, which is, as a consequence, currently active in South Africa, Canada, Morocco, New Zealand and in the Caribbean region. The program has plans to expand to Chile, Argentina, Brazil and the USA (The Blue Flag, 2008).

In 2008, over 3300 beaches and marinas worldwide were awarded the Blue Flag. The award of Blue Flag beach and marina certification is based on compliance with 29 criteria for beaches and 23 criteria for marinas, covering many aspects of environmental education and information, water quality, environmental management, and safety and services (Appendix B). Furthermore, these criteria are grouped by their relative importance into three categories: imperatives, guidelines, and non-applicable (NA) for certain regions. All imperative requirements have to be fulfilled to gain certification, and a minimum number of guidelines must be met in addition. Blue Flags are awarded on a season-by-season basis, only.

Blue Flag certification, and the information it conveys, is relevant to public benefits of services that this certification induces. For example, entities applying for Blue Flag certification are required to display information relating to coastal zone ecosystems and natural, sensitive areas in the coastal zone (Appendix B). This information, in turn, implicitly informs tourists of the potential detrimental effects to these ecosystems that their activities may create. However, it can be argued that some of the information provided by the certification allows for the extraction of private benefits as well. For example, the requirement for adequate beach or marina waste management not only provides a public benefit, but signals a service that privately benefits local consumers. I treat the certification as primarily relevant to public benefits. For my empirical analysis, available information about the nature of services in a given marina or a beach has been collected, and any remaining quality variables are left as unobserved heterogeneity, accommodated analytically via panel data methods.

I choose the Croatian Adriatic Sea region, located in south-eastern Europe, as the venue for this empirical illustration because of its unique natural endowments that support sun-and-beach tourism. It is a particularly suitable case for this study because water quality, a possible confounding factor that might affect prices of tourism services and certification statuses, does not have much variation in the area. Some 95% of locations tested for water quality by the Croatian Ministry of Environmental Protection, Physical Planning and Construction have been found to have “excellent” water quality. The remaining locations have “good” water quality. Croatia is a representative case of a tourism based economy, with tourism sector share of GDP of 20%. It is a top 20 tourism destination in the world, with majority of arrivals concentrated in the Adriatic Sea region.

Croatia’s coastline is 5835 kilometers long, of which 4058 kilometers are attributed to its 1185 islands of which only 66 are permanently inhabited (see Figure 1).[1] The Adriatic region is characterized by a mild Mediterranean climate where summers are hot and dry and winters mild. Average August air temperature is between 22°C and 25°C, while the Adriatic Sea has an average temperature of 25°C during the summer.[2] In 2008, there were some 57 million tourist night stays, of which 95.6% occurred in the Adriatic Coast Region.[3] Some 89% of all overnight stays were consumed by foreign tourists. 119 beaches and 18 marinas in Croatia have been awarded the Blue Flag certification, and customer satisfaction in the Croatian hotel and nautical tourism sectors ranks the highest in the natural beauty category and high in the ecological preservation category.[4]

In this paper I employ an original dataset pertaining to the sun-and-beach sector of the tourism industry in Croatia to analyze the effects of the Blue Flag eco-label for marinas and beaches on daily, monthly and yearly marina slip-rental prices; weekly sailboat charter prices; and average monthly hotel room prices. In my econometric analysis, I explore least squares, random effects and simultaneous equations methods. The paper’s main contribution lies in its focus on the services sector, as well as its use of

[1] CIA World Factbook listing for Croatia

[2] Croatian National Tourist Board

[3] 2008 Croatian Tourism in Numbers, Institute for Tourism

[4] 2007 TOMAS – Summer and 2007 TOMAS - Nautical

simultaneous equation techniques to model selection into the certification scheme. The price and amenity data have been extracted individually from online hotel, sailboat

Figure 1. Croatian Adriatic Region

Source: Google Maps

charter and marina brochures for the Croatian Adriatic Sea region in 2008. The data on Blue Flag certified marinas and beaches have likewise been collected from the brochures provided online by the FEE. The results suggest that Blue Flag certified marinas do command higher prices. In addition, sailboats whose home marina is awarded the Blue Flag carry a price premium for weekly sailboat rentals. Similarly, hotels managing a Blue Flag certified beach enjoy a significant price premium as well.

2.2. Literature Overview

A recent literature overview of eco-labeling literature by Blackman and Rivera (2010) provides a good summary of papers and issues commonly encountered in this literature. They identify 37 relevant studies focusing on the socioeconomic and environmental impacts of eco certification. Only 14 of these studies are found to use credible empirical strategies to identify the effects of certification. Specifically, these studies properly address the issue of selection into certification programs by using quasi-experimental methods and devising counterfactual outcomes. Only five of the 14 studies find positive socioeconomic impact of eco-labeling.

All but one of the five aforementioned studies focus on the impact of eco-labels in the agricultural sector. Fort and Ruben (2008) analyze the impact of fair-trade certified bananas on farmer incomes and profits in Peru. They construct a control group using propensity score matching based on several household characteristics. The authors find that fair-trade certification is associated with higher farmer incomes and profits. Arnould et al. (2009) focus on the impacts of fair-trade coffee certification on the volume of coffee sold and price of coffee in Nicaragua, Peru and Guatemala. They find evidence for both the price premium associated with the fair-trade certification. Becchetti and Costantino (2008) focus on fair-trade certification of a variety of agricultural products (lemons, mangos, etc.) in Kenya. They estimated its impact on a variety of socioeconomic outcomes, and find that fair-trade label is related to higher satisfaction with living conditions and superior nutritional quality among farmers participating in the program. Bolwig et al. (2009) study the impact of organic coffee certification on farmer incomes in Uganda. They employ the Heckman selection model and find that organic coffee certification increases net revenues by 75 percent on average.

There is only a single study that focuses on the impact of eco-labels in the tourism industry. Rivera (2002) analyzes the impact of Costa Rican national eco-tourism label, Certification for Sustainable Tourism, on the prices and sales of hotel rooms. Rivera employs a two-stage Heckman model to address selection of hotels into the label. His findings suggest the existence of a price premium associated with the Certification for Sustainable Tourism label.

One of the earliest papers on environmental labeling is Henion (1972) who analyzes changes in the market shares of various brands of detergent in response to the provision of information on each product's phosphate content. In the 1970's, phosphates had been found to produce a negative impact on the environment, primarily through over-fertilization of surface waters. Being a major contributor to the release of phosphates into the ecosystems, detergents came under intense public scrutiny, and a voluntary labeling scheme was devised to inform concerned consumers about the phosphate content of some brands. Henion (1972) found that labeling detergents with low phosphate counts had a positive effect on the market shares for these labeled detergents.

'Blue Angel' is one of the oldest environmental labels in the world, having operated independently in Germany since 1977. A Study by Hemmelskamp and Brotkmann (1997) look at the impact of the 'Blue Angel' label by estimating market shares for different brands of emulsion lacquer paints. The Blue Angel is a multi-category label, with specific criteria dictating each category. Their findings show that the label helps a product attain a greater market share, even when it is sold at a higher price.

However, authors note that,

> "The success of an environmental label is to be expected, particularly for those products where the individual consumer can expect a personal positive advantage by utilizing the labeled product. This can be an immediate individual benefit as well as an indirect benefit through a perceivable and comprehensible contribution to environmental protection. Environmental labels awarded to other product categories missing these characteristics will probably not be able to contribute substantially to the market performance of the labeled product" (Hemmelskamp & Brotkmann, 1997).

The only published study on Blue Flag certification by Nahman and Rigby (2008) estimates the costs associated with reduced water quality and withdrawal of Blue Flag status in Margate, Kwazulu-Natal. The authors use travel costs and contingent behavior methods and find that the cost of loss of Blue Flag status ranges between R17 and R25 million per annum.

In the existing eco-labeling literature, one of the commonly used empirical models has been the hedonic model. This model has proven to be especially useful in the examination of the relationship between a good's market price and consumer preferences for its different attributes. In the context of the present paper, the rental price for sailboats, marina slips and hotel rooms are modeled as functions of the bundles of attributes that each good represents. Hedonic price specifications can be constructed relatively easily, as all one needs is the service rental price, service and area attributes, and a plausible specification for the functional relationships between each different price and the relevant attributes.

2.3. Data

2.3.1. *Marina Slip-Rental Prices*

The data on all existing nautical tourism marinas in Croatia have been collected primarily from an online database provided by the Croatian Tourism Board (CTB). The dataset consists of records on marina characteristics, as well as links to daily, monthly and yearly slip-rental price brochures of all CTB categorized marinas. The entire marina population is available, so there is no possibility of selection bias. The dataset on daily marina slip rental prices contains price information for 43 marinas, *i*, each supplying slips in some 22 boat-length categories, *j*, providing 9369 observations. Some marinas do not offer monthly slip rentals so the dataset on monthly marina slip rental prices contains information on 27 marinas and consequently has 5315 observations. Finally, the dataset consisting of yearly slip-rental prices consists of 38 marinas and 616 observations and is a cross-sectional dataset (since there is no month-to-month variation in yearly slip-rental prices within 2008 data).

For the year 2008, the following information on marina characteristics has been obtained from the FEE website and online marina brochures: marina Blue Flag certification status (the key variable in this study), the number of available slips, number of available dry dock berths, marina category, ACI (Adriatic Croatia International) membership (an established company known for quality of service), distance to the closest airport, distance to the closest marine fuel station, availability of laundry facilities, grocery stores, restaurants, a travel lift[5], a crane, on-site car parking and slipway launching ramp. About 45%, 51% and 52% of the marinas have been awarded the Blue Flag certification in the daily, monthly and yearly slip-rental price datasets, respectively; most have a restaurant and car parking (as do all marinas in the yearly slip-rental dataset), and a grocery store on premises, while about a third in all datasets own a travel lift crane. Marinas offer only berthing services (i.e. parking spots for boats, often with hook-ups available for electricity, water, and pump-out services for sewage holding tanks) and they do not participate, themselves, in sailboat rentals. Descriptive statistics for all of the variables used in the marina slip-rental specifications featured in this paper are presented in Table 1.

The dependent variable in the marina slip-rental price specifications is marina slip rental price for daily, monthly or yearly periods. These rental prices are expected to vary with marina characteristics. Marinas typically price each slip by the length of the boat it is designed to accommodate. These price differentials are warranted by the higher costs incurred by the marinas for larger boats, in terms of the quantity of services provided. Longer boats typically accommodate more passengers, for example, so they will tend to use more electricity and water and they are thus expected to pay higher slip-rental prices. From the point of view of the marina, longer slips at a marina come at the cost of fewer smaller slips, so this pricing differential also reflects opportunity costs.

[5] Elevator

Table 1. Summary statistics for marina daily, monthly and yearly slip rental prices and associated characteristics

	Daily slip rentals		Monthly slip rentals		Yearly slip rentals	
Variables	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Marina characteristics						
1(Blue Flag certified marina)	0.453	--	0.514	--	0.521	--
Slip rental price (Euros)	88.1	89	1192	1021	5887	3939
1(ACI Marina)	0.542	--	0.687	--	0.513	--
Marina category (1 through 3, and uncategorized)	2.22	0.744	1.98	0.637	2.06	0.658
Slips (number of available spots)	307	219	282	164	320	215
Dry dock (number of available spots)	87.6	97.8	70	67.6	90.5	91.6
1(Travel lift)	0.366	--	0.388	--	0.386	--
1(Grocery store)	0.951	--	0.941	--	0.95	--
1(Restaurant)	0.977	--	0.971	--	1	--
1(Laundry facilities)	0.589	--	0.614	--	0.66	--
1(Crane)	0.768	--	0.758	--	0.824	--
1(Parking)	0.947	--	0.972	--	1	--
1(Slipway)	0.582	--	0.632	--	0.664	--
Locational characteristics						
Marine fuel station distance (km)	2.81	3.99	2.51	3	2.41	3.96
Airport distance (km)	30.7	19.3	34.2	20.36	30.6	19.3
1(Island location)	0.355	--	0.368	--	0.295	--
Population (of the associated urban area)	18810	37595	18323	41342	21248	38976
1(Urban location)	0.901	--	0.972	--	0.97	--
Average county monthly tourist arrivals	140043	177502	149136	182697	9516	6127

Notes: Data on 2008 daily slip rentals have 9528 observations; monthly slip rentals have 5319 observations; yearly slip rentals have 616 observations.

2.3.2. *Sailboat Charter Prices*

The dependent variable in the second set of models is the weekly sailboat charter price. This specification assumes that sailboat charter prices are a function of various sailboat characteristics, as well as various locational characteristics. The sailboat charter data have been collected from the brochures of a single tour agency.[6] Since this is a

[6] Adriatica.net

convenience sample, there is some concern regarding selection bias.[7] The dataset contains information on sailboat characteristics such as: weekly price, home marina Blue Flag certification status, boat age, length, number of beds, water and fuel capacity, as well as other various amenities, ranging from the availability of stove/cooker to radio equipment.

The dependent variable, weekly sailboat charter prices, typically varies by week over the season and is collected for all 52 weeks of the year, for 273 boats, to produce a dataset of 16307 observations. Weekly charter prices range from a low of 300 Euros during October through April, to about 7500 Euros at the peak of the season in the mid-August. On average, however, a weekly sailboat rental costs about 1957 Euros. Charter companies typically pay 3959 Euros for a yearly slip rental at their home marina. The average sailboat in the sample is about twelve meters long and is around ten years old. Roughly 70% of boats are housed in Blue Flag certified marinas. Descriptive statistics for all of the variables used in the sailboat charter price specifications featured in this paper are presented in Table 2.

2.3.3. *Hotel Room Prices*

The final dataset, consisting of average monthly hotel room prices and characteristics data, has been collected from individual hotel brochures. Data on all of the registered hotels in Croatia was obtained from the Croatian Ministry of Tourism (CMT). From this list I selected a “county-by-hotel category” stratified sample (Table A1) from the coastal counties in Croatia. Given the stratified random sampling strategy, selection

[7] Adriatica.net, one of the largest Croatian tour agencies, provides services for the entire Adriatic Sea region and personal interviews with firm managers indicate that no specific region or boat type are over or under represented in their offer.

bias is of minimal concern. The sample consists of 97 hotels (out of 440 in the population, Table A1) for which information was collected on variables such as: average monthly hotel room prices, hotel beach Blue Flag certification status, number of rooms, hotel category (2 through 5 stars), distance to an airport, population of the associated urban area, an indicator for air-conditioning in rooms and sports facilities. Some 9.5% of all the hotels in the population, and 9.3% in the sample, are associated (as both applicants for the certification and in charge of maintenance) with beaches that have been awarded the Blue Flag (Appendix A Table 1).

Table 2. Summary statistics for weekly sailboat charter price and associated characteristics

Variables	Mean	Std. Dev.
Marina characteristics		
1(Blue Flag certified marina)	0.694	--
Marina yearly slip rental price (Euros)	3959	900
Vessel characteristics		
Weekly sailboat charter price	1957	895
Ship length (meters)	12.5	1.9
Number of beds	7.07	1.92
Vessel age (years)	10.3	111
Vessel weight (tons)	4.48	4.59
Fuel capacity (liters)	0.176	0.09
1(Nautical charts and guides)	0.947	--
1(Global positioning system)	0.931	--
1(Marine VHF radio)	0.978	--
1(Electric refrigerator)	0.52	--
1(Gas cooker with oven)	0.361	--
1(Electric winch for anchor)	0.009	--
Locational characteristics		
Average county monthly tourist arrivals	119688	152145

Notes: Data on 2008 weekly sailboat charters have 16307 observations.

Table 3. Summary statistics for hotel room prices and associated characteristics

Variables	Mean	Std. Dev.
Hotel characteristics		
1 (Blue Flag awarded to the hotel beach)	0.0927	--
Hotel room price (Euros)	73.9	52.8
Hotel category (2 through 5 stars)	3.17	0.799
Number of rooms	98.5	95.5
1(Air-conditioning)	0.619	--
1(Sports facilities)	0.309	--
Locational characteristics		
Airport distance (km)	35.5	25.4
Population (in associated urban area, in thousands)	22.9	45.7
1 (Island location)	0.268	--
Average county monthly tourist arrivals (in thousands)	143	175

Note: Data on 2008 hotel room prices have 969 observations.

2.4. Empirical Methodology

2.4.1. *Marina Slip-Rental Prices*

The hedonic price equation for the marina data uses a standard semi-log functional form, with the logarithms of either marina daily, monthly or yearly slip rental prices as dependent variables.[8] This specification is adopted because of its widely accepted use in the hedonic literature (Palmquist, 1991). The primary goal of estimation is to identify the implicit marginal prices associated with Blue Flag certification of marinas, while controlling for other attributes of each good. The logarithms of the daily, monthly and yearly slip rental prices are, therefore, regressed on an indicator for marina Blue Flag certification status, as well as other marina-level and locational (city and county) controls, using least squares methods, random effects specifications for the error term, and simultaneous equations methods. Fixed effects specifications cannot be used

[8] Slips can be rented at any of the three durations.

since the variable of interest, $BlueFlag_i$, is a time-invariant dummy within each year and no new Blue Flags were awarded during the time-period.[9] The random effects specification is used to account for unobserved heterogeneity.[10] Thus the following econometric specification is proposed,

$$\ln SlipPrice_{cijt} = \beta_0 + \beta_1 BlueFlag_i + \sum \beta_i X_i + \sum \beta_c Z_c + \sum \beta_{ct} Z_{ct} + \varepsilon_{cijt} \tag{1}$$

where $SlipPrice_{cijt}$ refers to the daily slip-rental price, in county c, at marina i, for each boat length j, at time t; $BlueFlag_i$ is an indicator for marina Blue Flag certification status, which is expected to be positively related to $SlipPrice_{cijt}$; the vector X_i contains time-invariant marina specific attributes such as: number of slips, dry dock berths, marina category, distance from an airport and marine fuel station, and dummies for the availability of a grocery store, a restaurant, laundry facilities, a travel lift, a crane, a parking, a slipway and an Adriatic Croatia International (ACI) club; Z_c contains data on time-invariant characteristics of the area where the marina is located, such as: indicators for urban and island locations, and the population of the associated urban area. Z_{ct} contains data on average monthly county-level tourist arrivals, which is a time-varying (across the months of 2008) characteristic of the area where the marina is located. The coefficient on average monthly county-level tourist arrivals is estimated only for daily and monthly slip rental prices, since yearly slip rentals are time-invariant annual contracts.[11]

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[9] Data are only available for the twelve months of 2008.

[10] The unobserved effect is dealt with by assuming that each error component which captures unobserved heterogeneity is being drawn randomly from a given distribution.

[11] Yearly slip rental data are thus cross sectional.

To attain Blue Flag certification, marinas have to apply with the local representative of the FEE and provide extensive information on their environmental management policies, environmental education and information programs, safety measures and water quality. Therefore, it is apparent that some form of selection into the certification scheme may exist, because some marinas are likely to be more prepared, informed, and inclined to pursue the certification. To control for the potential endogeneity of a marina's Blue Flag certification status, I propose two instruments: the number of *other* Blue Flag certified marinas in the county, $CountyBFMarinas_c$, and the number of *other* Blue Flag certified marinas owned by the firm which owns marina i, $FirmBFMarinas_i$. The former increases the awareness about the label in the county and consequently is likely to prompt other local marinas to look into applying for the label. The latter performs a similar function, as firms that have already had experience applying for and obtaining the certification are going to be more informed about the application process and the label itself, and thus find it less costly to apply for certification for another marina they own. The proposed first-stage specification is,

$$BlueFlag_{\mathrm{i}} = \beta_0 + \beta_1 CountyBFMarinas_c + \beta_2 FirmBFMarinas_i + \sum \beta_i X_i + \varepsilon_i \qquad (2)$$

The second stage is estimated by equation (1). X_i contains all the time-invariant marina characteristics. The set of equations is estimated using both the two-stage least squares (2SLS) estimator, as well as a generalized least squares (GLS) random effects two-stage least squares (RE 2SLS) estimator.

2.4.2. *Sailboat Charter Prices*

The second hedonic price equation is estimated using the sailboat charter data and is also specified with a semi-log functional form. Again, the goal is to identify implicit marginal prices associated with various sailboat attributes. Fixed effects specifications are again precluded because the variable of interest, $BlueFlag_i$, is a time-invariant indicator. Thus, using least squares methods and a random effects specification for the error term, the logarithm of sailboat charter price in county *c*, home marina *i*, sailboat *s*, at time *t*, is regressed on the indicator for the Blue Flag status at the home marina, yearly slip rental price of the home marina, as well as other sailboat level and locational (city, region and county) controls using the following econometric specification:

$$\ln CharterPrice_{cist} = \beta_0 + \beta_1 BlueFlag_i + \beta_2 SlipRental_{is}^{HM} + \sum \beta_s X_s + \sum \beta_{ct} Z_{ct} + \varepsilon_{cist} \qquad (3)$$

where $CharterPrice_{cist}$ refers to the sailboat charter price in county *c*, home marina *i*, sailboat *s*, at time *t*; $BlueFlag_i$ is an indicator for the Blue Flag certification status, which is expected to be positively related to $CharterPrice_{cist}$; $SlipRental_{li}^{HM}$ is the yearly slip rental price for the home marina representing a fixed cost for boat parking that each charter company must incur; X_s contains time-invariant sailboat attributes such as: length, age, number of cabins and beds, water and fuel tank capacity, as well as binary indicators for the availability of an electric refrigerator, a gas stove, nautical charts, a Global Positioning System (GPS), VFH radio, and electric anchor winch; Z_{ct} contains data on average monthly county-level tourist arrivals, a time-varying location-specific characteristic.

Again, in order to address the potential of endogeneity of Blue Flag certification status I propose two instruments (for the same reasons as in the previous case of marinas): the number of other Blue Flag certified marinas in the county, *$CountyBFMarinas_c$*, and the number of other Blue Flag certified marinas owned by the firm which owns marina *i*, Firm*$BFMarinas_i$*. Thus, the proposed first-stage specification is,

$$BlueFlag_{is} = \beta_0 + \beta_1 CountyBFMarinas_c + \beta_2 FirmBFMarinas_i + \sum \beta_i X_{is} + \varepsilon_{is} \qquad (4)$$

whereas the second stage is estimated by equation (3). X_i contains time-invariant marina and sailboat characteristics, such as the number of slips and ACI status. Again, the set of equations is estimated using both the two-stage least squares (2SLS) estimator, as well as generalized least squares (GLS) random effects two-stage least squares (RE 2SLS). Specification (4) is different from specification (2) in that it includes only the home marinas associated with sailboats in the sample, not all marinas.

2.4.3. *Hotel Room Prices*

The final hedonic specification is estimated using hotel data. Again, a semi-log functional form is used to identify implicit marginal prices associated with various hotel characteristics. Consistent with the previous two cases, the logarithm of average monthly hotel room price *i*, at time *t*, is regressed on the indicator of Blue Flag status for the hotel's own beach, as well as other site and locational controls. The following econometric specification is proposed:

$$\ln HotelRoomPrice_{cit} = \beta_0 + \beta_1 BlueFlag_i + \sum \beta_i X_i + \sum \beta_{ct} Z_{ct} + \gamma_i + \varepsilon_{cit} \qquad (5)$$

where $HotelRoomPrice_{it}$ refers to the average daily hotel room price[12] at hotel i, in a county c, in a month t; $BlueFlag_i$ is an indicator for the Blue Flag certification status of the hotel's own beach[13], which is expected to be positively related to $HotelRoomPrice_{it}$; X_i contains time-invariant hotel attributes such as availability of air-conditioning in rooms, availability of sports facilities on the premises and number of rooms; Z_{ct} contains data on average monthly county-level tourist arrivals; γ_i stands for city fixed effects shared by all hotels associated with a given city. Such fixed effects are warranted in this specification, as tourists staying in hotels tend not to come for the hotel itself or even just for the sun-and-beach' attributes of the hotel. They also come for various other amenities (historical, architectural and gastronomic) offered by the local culture. These sources of unobserved heterogeneity are captured by city fixed effects.

As in the case of marinas, for a hotel to attain Blue Flag certification for the hotel's own beach, it has to apply to the local representative of the FEE and provide extensive information on its environmental management policies, environmental education and information programs, safety and water quality. Consequently, the issue of endogeneity arises again and to deal with this problem I propose two instruments: the number of other Blue Flag certified beaches in the county, $CountyBFBeaches_c$, and the number of other Blue Flag certified beaches owned by the firm which owns hotel i, $FirmBFBeaches_i$. Thus, the proposed first-stage specification is,

$$BlueFlag_{\mathrm{i}} = \beta_0 + \beta_1 CountyBFBeaches_c + \beta_2 FirmBFBeaches_i + \sum \beta_i X_i + \varepsilon_i \qquad (6)$$

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[12] Hotel room price data were collected specifically as the per-person cost of renting a two-bed park-view (as opposed to a sea-view) room that includes half-board.

[13] All hotels in the sample are in close proximity to the sea.

whereas the second stage is estimated by equation (5). The set of equations is estimated using both the two-stage least squares (2SLS) estimator, and a generalized least squares (GLS) random effects two-stage least squares (RE 2SLS) estimator.

2.5. Empirical Results

2.5.1. *Marina Slip-Rental Prices*

The estimated results for daily marina slip rental prices are presented in Table 4. Column 1 displays least squares estimates, and column 3 gives the corresponding random effects estimates. Column 2 presents 2SLS second stage estimates for equation (1), and column 4 displays the random effects 2SLS second stage estimates for equation (1)[14]. For the estimator in the same order, Table 5 presents estimated results for the *monthly* marina slip-rental price specification and Table 6 presents estimated results for *yearly* marina slip-rental price specification. These specifications vary somewhat across the different durations of marina slip-rentals because not all marinas offer all three of daily, monthly and yearly services.[15] Specifically, while all 42 marinas in the sample offer daily rates, only 27 marinas offer monthly slip rentals. Similarly, 38 marinas offer yearly slip rental services, and all of these marinas happen to have restaurants. Also, the yearly marina slip-rental prices do not exhibit changes during the time frame (a single year, 2008) for the sample. Yearly service is created for individuals and companies wishing to make a particular marina their home marina. These customers are important for marinas, since they consume other marina services in the off-season. To attract them, marinas offer

[14] First stage results are presented in the Appendix A Tables A2, A3 and A4 for daily, monthly and yearly marina slip-rental specifications.

[15] Seemingly Unrelated Regressions (SUR) cannot be applied here, since the regressors are identical in all three cases.

fixed yearly contracts at an effective daily rate that is much lower than for transient boats. All marinas in the sample are specialized as nautical tourism marinas, and they do not offer significant services other than the ones used in this study (i.e. yacht clubs catering to other social events are not common).

Most importantly, the results of the four proposed specifications suggest that marinas awarded Blue Flag certification enjoy an average premium between 6.6% and 22% in terms of their daily slip-rental prices; an average premium between 40% and 49% in terms of their monthly slip-rental prices; and a 23% premium in terms of their yearly slip-rental prices. In case of instrumental variables specifications, the proposed instruments seem to be appropriate[16]. The number of slips in a marina significantly impacts monthly and yearly slip-rental prices. For monthly rates the results suggest decreasing economies of scale, while for yearly rates they imply increasing economies of scale. The difference in estimates between the two kinds of slip rental rates suggests dissimilarities in the nature of these contracts. Smaller marinas tend to face lower costs and thus have an advantage over their larger counterparts in offering cheaper long term boat parking service.

[16] F-stat= 4877 for daily; F-stat= 6311 for monthly; and F-stat= 339 for yearly marina slip-rental price specifications.

Table 4. Determinants of Daily log(Marina Slip-rental Prices) (n=9396)

Variables	(1) OLS	(2) 2SLS	(3) RE	(4) RE 2SLS
Marina characteristics				
1(Blue Flag certified marina)	0.215***	0.0669*	0.228***	0.0895
	(0.026)	(0.037)	(0.086)	(0.12)
log(Slips) (number of available spots)	-0.0208	0.00941	-0.0369	-0.0098
	(0.023)	(0.024)	(0.076)	(0.078)
1(ACI Marina)	0.359***	0.330***	0.365***	0.338***
	(0.023)	(0.023)	(0.075)	(0.077)
1(Second tier marina)	-0.144***	-0.163***	-0.137*	-0.154*
	(0.025)	(0.025)	(0.083)	(0.083)
1(Third tier marina)	0.0262	-0.0795**	0.0407	-0.058
	(0.033)	(0.038)	(0.11)	(0.13)
1(Uncategorized marina)	0.272***	0.222***	0.276	0.229
	(0.053)	(0.054)	(0.18)	(0.18)
Dry dock (number of available spots)	0.000371**	0.000364**	0.000446	0.000447
	(0.00016)	(0.00016)	(0.00053)	(0.00054)
1(Travel lift)	0.0963***	0.0449	0.116	0.0688
	(0.031)	(0.033)	(0.1)	(0.11)
1(Grocery store)	0.0377	0.0413	0.0278	0.0303
	(0.037)	(0.037)	(0.12)	(0.12)
1(Restaurant)	0.249***	0.251***	0.258	0.261
	(0.054)	(0.054)	(0.18)	(0.18)
1(Laundry facilities)	0.0251	0.0790***	0.0205	0.0712
	(0.026)	(0.027)	(0.085)	(0.091)
1(Crane)	-0.257***	-0.273***	-0.249***	-0.264***
	(0.029)	(0.029)	(0.096)	(0.097)
1(Parking)	-0.484***	-0.426***	-0.487***	-0.433**
	(0.053)	(0.054)	(0.17)	(0.18)
1(Slipway)	-0.136***	-0.162***	-0.138**	-0.163***
	(0.018)	(0.018)	(0.058)	(0.06)
Locational characteristics				
log(Airport distance, km)	0.0299**	0.0367**	0.0363	0.0433
	(0.015)	(0.015)	(0.049)	(0.049)
Marine fuel station distance (km)	-0.00645***	-0.0102***	-0.00537	-0.00879
	(0.0024)	(0.0025)	(0.0079)	(0.0082)
1(Island location)	0.00263	0.0716**	-0.0117	0.0523
	(0.028)	(0.031)	(0.094)	(0.1)
Population (of the associated urban area, in thousands)	0.00214***	0.00233***	0.00219**	0.00237***
	(0.00026)	(0.00027)	(0.00087)	(0.00088)
1(Urban location)	0.601***	0.566***	0.586***	0.551***
	(0.036)	(0.036)	(0.12)	(0.12)
log(Average county monthly tourist arrivals)	0.0980***	0.0955***	0.122***	0.122***
	(0.0045)	(0.0045)	(0.0014)	(0.0014)
Constant	2.688***	2.622***	2.479***	2.397***
	(0.14)	(0.14)	(0.45)	(0.45)
R^2	0.18	0.18	0.17	0.17

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, *p<0.1.

Table 5. Determinants of Monthly log(Marina Slip-rental Prices) (n=5315)

Variables	(1) OLS	(2) 2SLS	(3) RE	(4) RE 2SLS
Marina characteristics				
1(Blue Flag certified marina)	0.489***	0.407***	0.497***	0.418***
	(0.035)	(0.041)	(0.12)	(0.14)
log(Slips) (number of available spots)	-0.235***	-0.243***	-0.263*	-0.273*
	(0.043)	(0.043)	(0.14)	(0.14)
1(ACI Marina)	0.336***	0.326***	0.353***	0.345***
	(0.034)	(0.034)	(0.11)	(0.11)
1(Second tier marina)	-0.289***	-0.327***	-0.288**	-0.325***
	(0.033)	(0.034)	(0.11)	(0.12)
1(Third tier marina)	-0.144***	-0.191***	-0.138	-0.184
	(0.041)	(0.043)	(0.14)	(0.15)
1(Uncategorized marina)	--	--	--	--
	--	--	--	--
Dry dock (number of available spots)	0.00260***	0.00275***	0.00279**	0.00295**
	(0.00041)	(0.00041)	(0.0014)	(0.0014)
1(Travel lift)	0.478***	0.447***	0.498***	0.469***
	(0.042)	(0.042)	(0.14)	(0.14)
1(Grocery store)	0.173***	0.187***	0.166	0.18
	(0.038)	(0.038)	(0.13)	(0.13)
1(Restaurant)	-0.124*	-0.0655	-0.12	-0.0626
	(0.071)	(0.073)	(0.25)	(0.25)
1(Laundry facilities)	-0.349***	-0.328***	-0.359***	-0.339***
	(0.028)	(0.029)	(0.095)	(0.097)
1(Crane)	0.114***	0.0958***	0.128	0.112
	(0.036)	(0.036)	(0.12)	(0.12)
1(Parking)	--	--	--	--
	--	--	--	--
1(Slipway)	0.209***	0.179***	0.208***	0.180**
	(0.022)	(0.023)	(0.076)	(0.08)
Locational characteristics				
log(Airport distance, km)	0.125***	0.122***	0.133**	0.131**
	(0.017)	(0.017)	(0.059)	(0.058)
Marine fuel station distance (km)	0.0155***	0.00901	0.0167	0.0105
	(0.0053)	(0.0056)	(0.018)	(0.019)
1(Island location)	-0.482***	-0.411***	-0.503***	-0.436**
	(0.049)	(0.053)	(0.17)	(0.18)
Population (of the associated urban area, in thousands)	0.00238***	0.00267***	0.00245**	0.00274**
	(0.00031)	(0.00032)	(0.0011)	(0.0011)
1(Urban location)	-1.345***	-1.286***	-1.348***	-1.291***
	(0.071)	(0.072)	(0.22)	(0.23)
log(Average county monthly tourist arrivals)	0.0470***	0.0459***	0.0598***	0.0598***
	(0.0052)	(0.0052)	(0.0012)	(0.0012)
Constant	7.909***	7.935***	7.857***	7.878***
	(0.2)	(0.2)	(0.66)	(0.65)
R^2	0.29	0.29	0.29	0.29

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, *p<0.1. S

Table 6. Determinants of Yearly log(Marina Slip Rental-prices) (n=616)

Variables	(1) OLS	(2) 2SLS
Marina characteristics		
1(Blue Flag certified marina)	0.232***	0.137
	(0.072)	(0.01)
log(Slips) (number of available spots)	0.124*	0.148**
	(0.065)	(0.066)
1(ACI Marina)	0.167**	0.144**
	(0.063)	(0.064)
1(Second tier marina)	-0.196***	-0.210***
	(0.070)	(0.070)
1(Third tier marina)	-0.0537	-0.119
	(0.091)	(0.10)
1(Uncategorized marina)	0.139	0.0923
	(0.21)	(0.21)
Dry dock (number of available spots)	-0.000126	-0.000176
	(0.00046)	(0.00046)
1(Travel lift)	0.0701	0.0321
	(0.092)	(0.09)
1(Grocery store)	0.161	0.167
	(0.10)	(0.10)
1(Restaurant)	--	--
	--	--
1(Laundry facilities)	0.0511	0.0868
	(0.071)	(0.075)
1(Crane)	-0.104	-0.124
	(0.089)	(0.089)
1(Parking)	--	--
	--	--
1(Slipway)	0.182***	0.162***
	(0.05)	(0.050)
Locational characteristics		
log(Airport distance, km)	-0.106***	-0.104***
	(0.040)	(0.040)
Marine fuel station distance (km)	-0.0140**	-0.01650**
	(0.0064)	(0.006)
1(Island location)	-0.0688	-0.0114
	(0.089)	(0.09)
Population (of the associated urban area, in thousands)	0.000351	0.000485
	(0.00073)	(0.00074)
1(Urban location)	-0.115	-0.169
	(0.14)	(0.14)
Constant	8.00***	8.00***
	(0.32)	(0.32)
R^2	0.2	0.2

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, *p<0.1.

Marinas owned by ACI, command an average premium between 33% and 36% in terms of their daily slip rental prices; an average premium between 32% and 35% in terms of their monthly slip rental prices; and an average premium between 14% and 17% in terms of their yearly slip rental prices. Across the four specifications, the estimates for second-tier marinas (as defined by the Croatian Tourist Board) suggest that second-tier status has a significant and negative impact on all three slip-rental rates, relative to the highest quality, first-tier, marinas. However, these effects are less statistically significant for third-tier (although they are negative when significant) and uncategorized marinas. Furthermore, marinas offering travel lift, crane and slipway services command a price premium for monthly slip-rentals, while these features seem to have be negatively associated with daily slip rental prices. This points to a difference in the nature of the two types of contracts. Marinas that invest in heavy machinery (such as cranes) tend to cater more to consumers who seek mechanical and boat maintenance services. These services are typically associated with longer stays, so these marinas may exploit different demand elasticities, by channeling the associated capital costs to customers demanding these services, while relieving short term patrons of these costs. The results also indicate that dry dock parking services are also passed on to longer-term patrons, such as customers renting slips at monthly rates.

In terms of marina locational characteristics, accessibility matters for some types of slip-rentals: distance from an airport negatively affects the yearly slip-rental prices. For every 1% increase in the distance between a marina and the nearest airport, the average price of a *yearly* slip-rental decreases by 0.21%. On the other hand, a 1% increase in distance from the nearest airport leads to an average increase of 0.13% in the monthly slip-rental price. This suggests that long-term patrons are willing to pay a premium for proximity to the main transportation hubs. Among other variables, marinas located on islands tend to charge a 43% lower price, on average, for a monthly slip-rental than marinas on the mainland. However, this impact is not robust across specifications for daily and yearly slip rentals. Such results suggest that accessibility might matter in the case of very short-term customers, such as tourists, since islands are less convenient and more costly to reach than mainland locations. Average monthly tourism flows have a positive and significant impact on daily and monthly rental prices and this result is robust across specifications.

2.5.2. *Sailboat Charter Prices*

The estimation results for equation (3) are presented in the Table 7[17]. Again, column 1 displays least squares estimates, and column 3 gives random effects estimates. Column 2 presents 2SLS second stage estimates from equation (3). Column 4 shows random effects 2SLS second stage estimates from equation (3).

Overall, the main estimation results suggest that sailboats berthing in a marina certified with the Blue Flag command, on average, a price premium between 14% and 20% on a weekly sailboat rental. In case of instrumental variables specifications, the proposed instruments seem to be appropriate[18]. This result is robust across specifications. This is in line with the theoretical prediction which suggests that eco-labeling certification attained by a home marina provides a signal of local environmental quality. This certification is,

[17] First stage estimates are presented in Appendix A Table A.5.

[18] F-stat=768.

in turn, reflected in weekly sailboat rental prices, which are more likely to reflect tourist demands.

Table 7. Determinants of the log(Weekly Sailboat Charter Price) (n=16651)

Variables	(1) OLS	(2) 2SLS	(3) RE	(4) RE 2SLS
Marina characteristics				
1 (Blue Flag certified home marina)	0.158***	0.140***	0.181***	0.205***
	(0.0062)	(0.0055)	(0.033)	(0.034)
log (Marina yearly slip rental price)	-0.0225	0.0617***	-0.0855	-0.121*
	(0.014)	(0.0073)	(0.072)	(0.073)
Vessel characteristics				
log(Sailboat length) (meters)	2.199***	2.209***	2.257***	2.295***
	(0.025)	(0.025)	(0.13)	(0.13)
Number of beds	-0.0360***	-0.0393***	-0.0381***	-0.0384***
	(0.0016)	(0.0016)	(0.0089)	(0.0087)
Vessel age (years)	-0.0115***	-0.0103***	-0.01000**	-0.0104**
	(0.0008)	(0.00079)	(0.0043)	(0.0042)
Vessel age^2 (years)/10^6	0.572***	0.515***	0.499**	0.521**
	(0.04)	(0.039)	(0.21)	(0.21)
Vessel weight (tons) /10^3	0.00286***	0.00296***	0.00295	0.00275
	(0.00044)	(0.00044)	(0.0024)	(0.0023)
Fuel capacity (tons)	0.558***	0.470***	0.605***	0.617***
	(0.031)	(0.029)	(0.17)	(0.16)
1(Nautical charts and guides)	0.0915***	0.107***	0.0896**	0.0864**
	(0.007)	(0.0068)	(0.038)	(0.037)
1(Global positioning system)	0.0451***	0.0587***	0.0382	0.0307
	(0.007)	(0.0067)	(0.038)	(0.037)
1(Marine VHF radio)	0.0266**	0.0399***	0.024	0.0112
	(0.011)	(0.011)	(0.058)	(0.057)
1(Electric refrigerator)	0.0212***	0.0271***	0.0134	0.016
	(0.0049)	(0.0049)	(0.026)	(0.026)
Gas cooker with oven (1 if available, 0 otherwise)	0.0351***	0.0249***	0.0376	0.0392
	(0.005)	(0.0048)	(0.027)	(0.026)
1 (Electric anchor available)	-0.000422	-0.00799	0.00632	0.00585
	(0.016)	(0.016)	(0.088)	(0.086)
Locational characteristics				
log(Average county monthly tourist arrivals, thousands)	0.122***	0.123***	0.123***	0.123***
	(0.001)	(0.001)	(0.00074)	(0.00074)
Constant	0.726***	--	1.083**	1.285**
	(0.096)	--	(0.5)	(0.5)
R^2	0.84	0.84	0.83	0.83

The estimated effects of other variables of interest, including vessel length, weight and age are all statistically significant with predicted signs, and robust across the four specifications. For example, a 1% increase in sailboat length yields, on average, a 2%

increase in its weekly charter price. Interior space (i.e. hull volume) increases faster than vessel length, so this result is not surprising. Availability of a nautical charts and guides increases the rental price by 9%, while an extra bed decreases it by about 4%, controlling for boat size. The number of tourist arrivals in the county (a variable proxying for demand conditions) is positively and significantly related to weekly sailboat charter prices. Furthermore, the estimated coefficient for the effect of yearly marina slip-rental prices on the weekly sailboat charter price is fragile and mostly insignificant.

2.5.3. *Hotel Room Prices*

The estimation results for equation (5) are presented in the Table 8[19]. Again, column 1 displays least squares estimates, and column 3 random effects estimates. Column 2 presents 2SLS second stage estimates from equation (5) and column 4 exhibits random effects 2SLS second stage estimates from equation (5). Most importantly, though, hotels whose beaches were awarded Blue Flag certification seem to command a significant price premium. Specifically, certification is associated with an increase in price of a hotel room between 45% and 270% in the OLS specifications, and between 49% and 237% in the random effects specifications. In case of instrumental variables specifications, the proposed instruments seem to be appropriate.[20]

In terms of the control variables, hotels categorized as 4-star and 5-star also carry a price premium, relative to 2-star hotels. Coefficient estimates suggest that a 4-star hotel carries a price premium between 33% and 51%, while a 5-star hotel carries a premium

[19] First stage estimates are presented in Appendix A Table A.6.

[20] F-stat=101.

between 100% and 118%. The number of beds is negatively and significantly related to hotel room prices, across specifications, which indicates presence of economies of scale. Other controls displaying robust coefficient estimates include the availability of air-conditioning in rooms and average county monthly tourist arrivals.

Table 8. Determinants of log(Hotel Room Prices) (n=969)

Variables	(1) OLS	(2) 2SLS	(3) RE	(4) RE 2SLS
1 (Blue Flag awarded to the hotel beach)	0.453***	2.705***	0.491*	2.376**
	(0.06)	(0.31)	(0.25)	(1.2)
log(Airport distance, km)	-0.222*	-1.286***	-0.294	-1.182
	(0.11)	(0.22)	(0.53)	(1.05)
1(3-star hotel)	0.00988	0.101*	-0.00243	0.0851
	(0.033)	(0.052)	(0.15)	(0.26)
1(4-star hotel)	0.495***	0.337***	0.518***	0.354
	(0.042)	(0.068)	(0.19)	(0.33)
1(5-star hotel)	1.180***	1.002***	1.166***	1.022**
	(0.053)	(0.084)	(0.24)	(0.42)
log(Number of rooms)	-0.190***	-0.207***	-0.178**	-0.209*
	(0.016)	(0.025)	(0.072)	(0.12)
1(Air-conditioning)	0.303***	0.425***	0.338**	0.412*
	(0.031)	(0.051)	(0.14)	(0.24)
1(Sports facilities)	0.000312	-0.563***	0.00778	-0.4
	(0.044)	(0.1)	(0.19)	(0.4)
1(Island location)	0.0861	2.836***	0.669	-1.266
	(0.38)	(0.36)	(0.63)	(2.65)
log(Population, in associated urban area, in thousands)	-0.119*	-0.645***	-0.158	-0.352
	(0.07)	(0.13)	(0.32)	(0.25)
log(Average county monthly tourist arrivals, in thousands)	0.122***	0.131***	0.122***	0.122***
	(0.0069)	(0.011)	(0.0043)	(0.0043)
Constant	4.477***	8.055***	4.276	9.257*
	(1.12)	(1.21)	(3.27)	(5.26)
R^2	0.83	0.56	0.82	0.68

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, *p<0.1. City fixed effects are included in the specification, but are supressed in the table for expository convinienice.

2.6. Conclusion

This study extends the existing literature concerning price premia associated with eco-labeling programs. In contrast to earlier work, this application focuses on services, which have been largely overlooked in the eco-labeling literature. A further contribution arises from the fact that this work specifically addresses the issue of selection into eco-labeling programs. I explicitly model the endogeneity of certification status using appropriate simultaneous equations techniques. In the analysis, three sectors of the tourism industry have been used to examine the effects of eco-certification on prices. Independently awarded eco-certification signals higher environmental quality and marinas awarded the Blue Flag certifications appear to be able to charge higher prices for their services. Moreover, charter companies associated with a marina that carries such a certification seem also to enjoy some benefits.

This study's principal findings include that Blue Flag certified marinas enjoy an average premium between 6.6% and 22% for *daily* slip rentals; 40% and 49% for *monthly* slip rentals; and 23% for *yearly* slip rentals. Furthermore, within the sailboat charter sector, vessels whose home marina is awarded the Blue Flag carry a price premium, on average, between 14% and 20% on a weekly sailboat rental. When it comes to hotel accommodation, hotels managing a Blue Flag certified beach enjoy a price premium between 45% and 270%.

These results suggest the importance of eco-labeling as a tool to decrease information asymmetry between consumers and service providers. The Blue Flag gives consumers information that reveals the relative environmental quality of marinas. This consequently increases demand for this comparatively more desirable recreational opportunity, which translates into higher price premiums charged by service providers. Furthermore, such a profit incentive can be expected to lead more marinas to make an effort to conform to the requirements for Blue Flag certification, in the hope that they too might be eligible for Blue Flag label. Therefore, the results of this analysis can be used in practice by marina-management companies to aid them in their decisions about whether to invest in environmentally friendly practices. These empirical insights may also be valuable to sailboat charter firms as they consider their selection of a home marina. More generally, this paper has shown that eco-labeling can be successfully applied to a service industry, and as such might encourage further research regarding similar certification programs that may emerge in other service industries.

CHAPTER III

CLIMATE CHANGE AND CIVIL WAR

3.1. Introduction

Climate change is predicted to have a range of potentially serious consequences in both the short and long terms. Near-term impacts may result from changes in regional temperature and precipitation averages and extremes (IPCC, 2001). Higher maximum temperatures lead to a host of impacts on both biological and physical systems. They are associated with increased incidence of death and illnesses in older age groups and amongst the poor, increased demand for electricity, damage to a variety of crops, livestock and wildlife. Higher minimum temperatures can lead to an increase in the range and activity of some pests and disease vectors. More intense precipitation events also negatively affect agricultural production, increase soil erosion, and increase the probability of floods and landslides.

Extended periods of low precipitation levels can lead to persistent droughts, leading to decreased crop yields and decreased water resource quantity and quality (IPCC, 2011). Furthermore, dry conditions increase the supply of combustible vegetation, increasing the risk of wildfires. The complex interaction between temperature and precipitation also impacts complex climate phenomena such as storms. For example, tropical cyclones derive energy primarily from evaporation from the ocean. Such evaporation increases with the increase in temperature, and is thus likely to increase the intensity of cyclones. Increase in cyclone peak wind and precipitation intensities lead to increased risk to human life, coastal erosion and damage to infrastructure. Finally, epidemics are likely to increase in frequency with increase in minimum temperatures, precipitation and flooding (IPCC, 2011). Longer-term impacts may include sea level changes with associated threats to coastal infrastructure and the potential for more frequent and severe outbreaks of vector-borne diseases (European Parliament, 2006).

The scope of these climate-induced challenges to human societies adds urgency to the need to identify and measure the potential effects of different types of disasters on various types of human activities. The goal of this research is to identify some of these effects and thereby inform climate change mitigation or adaptation policies. Recent research has predominantly considered the effects of climate change on economic activity and human health. However, the potential effect of climate change as a contributor to the outbreak of violent conflict has not been addressed in much detail until very recently in the quantitative literature (Blattman & Christopher, 2010). Economists and political scientists have just begun to look at these effects, but have yet to establish a persuasive weight of evidence that identifies the direction or the magnitude of the effects of different climate-related phenomena on violent conflict.

This study provides new evidence concerning the apparent impact of climate change on violent conflict. Specifically, I focus on climate change effects on the outbreak of civil war (*onset*), the persistence of civil war (*incidence*[21]) and the overall *duration* of civil war. I employ a dataset on the occurrence of climate-change-related natural disasters such as

[21] The variable called *incidence* is an indicator for whether there is a state of civil war in each country in each period

droughts, floods, storms, temperature extremes, wildfires and epidemics. I also take advantage of several standard datasets concerning civil wars from the political science literature compiled by Fearon and Laitin (2003) and Fearon (2004). By combining these datasets, I provide the first evidence that (a.) the frequency of extreme cold events and epidemic outbreaks appears to have a measurable effect on civil war *onset*; (b.) the frequency of the previous year's extreme heat events seems to affect civil war *incidence*; and (c.) the frequency of drought events appears to affect civil war *durations*. These climate-related events act as shocks to agricultural production, raising food prices and depressing incomes. In addition to these direct effects, these events also decrease the opportunity costs of conflict for the afflicted groups. The statistical regularities identified in this paper should be important to policymakers who struggle to decide upon optimal policies for international disaster relief related to extreme weather associated with climate change. In a broader context, these findings are also relevant to governments which must decide how aggressively to pursue climate change mitigation and adaptation measures.

Section 2 provides an overview of the related literature. Section 3 discusses the data. Section 4 explains the econometric specification and Section 5 summarizes the main results. Section 6 concludes.

3.2. Literature Overview

The impacts of climate change on various measures of civil war have been the focus of study by social scientists since the 1980s. It was first addressed in the environmental security literature. Employing qualitative research methodology, these studies found that conflict arises due to resource scarcity, which is in turn impacted by climate change. The quantitative approach to analyzing the issue is more new, first becoming the focus of political scientists in the 1990s, and only recently by economists. This paper contributes to the quantitative conflict literature by proposing a new set of explanatory variables, concerning climate-change-related disasters, previously not used in this literature, as major contributors to civil wars. It contributes to the larger conflict literature by identifying which climate-change-related disasters have an effect on civil war and which ones don't.

3.2.1. *Civil War Literature*

A literature review by Blattman and Christopher (2010) gives an excellent account of recent developments in research on the determinants of civil war. Using the terminology of Blattman and Christopher, this paper falls into the category of "cross-country empirical conflict research". This literature, and the associated theoretical research, is still evolving and many hypothesized relationships have yet to be thoroughly explored in empirical contexts. Much of the current quantitative research is based on civil war data collected by Fearon and Laitin (2003) and from Fearon (2004). This particular study uses civil war conflict data from Fearon and Laitin (2003) and from Fearon (2004) and extends specifications proposed in those papers, as well as in research by Collier and Hoeffler (1998).

Fearon and Laitin (2003) are motivated by the observation, in much of the prior descriptive research, that civil wars seem to be sparked by religious and ethnic antagonisms. However, their empirical results fail to confirm this perception. These authors argue that the onset of civil war is best explained by factors that induce or facilitate an armed insurgency against the government. Such factors include terrain accessibility, large populations and, most importantly, low incomes. High income countries are less likely to experience civil wars.

Chassang and Padro-i-Miquel (2008, 2009) develop a global game-theoretic model incorporating information asymmetries between actors. Enemies, in this case, do not know each other's costs of conflict. Their main finding suggests that higher incomes are linked to lower levels of conflict. Negative economic shocks, on the other hand, increase incentives for violent conflict since opposing groups experience a decrease in their opportunity costs of conflict (in terms of lower returns to production). Miguel et al (2004) address the issue of endogeneity of income growth in civil war incidence models. Specifically, they use rainfall variation as an instrument for economic growth in 41 African countries during 1981–99. This approach, however, cannot be applied in the case of climate-change-related disasters. Unlike rainfall, which is likely to influence civil war incidence only through an income shock to agricultural production, disasters affect the whole society in a variety of ways. They destroy infrastructure, such as schools and roads, and might affect access to education, contribute to migration, change in social customs (if a particular social group is affected, such as elderly and infants), etc.

Fearon (2004) is amongst the first papers that attempt to answer the question of why do certain civil wars last longer than others. He employs duration models in his analysis and finds that civil wars arising from coups or revolutions, and those originating in Eastern Europe and former colonies, tend to have shorter durations. Civil conflicts between ethnic minorities and government-backed migrants of a dominant ethnic group what the author terms "the sons of the soil" wars have longer durations. The same effect is found for conflicts in which the rebels have access to income from contraband (e.g.

opium, diamonds or coca). Other notable papers focusing on civil war duration find that outside interventions limit war duration (Reagan, 2002); presence of multiple actors players prolong it (Cunningham, 2006); conflicts located at considerable distance from the main government stronghold, along remote international borders and in regions with valuable minerals last substantially longer (Buhaug et al., 2009); and inequality lengthens civil wars (Collier et al, 2004).

3.2.2. *Effects of Temperature and Precipitation on Civil War*

In addition to the standard conflict literature, several recent attempts have been made to quantify the potential effects of climate change on various measures of violent conflict. The idea is that climate-change-related alterations in temperature and precipitation act as a negative income shocks which, according to Chassang and Padro-i-Miquel (2008, 2009), implies a higher potential for violent conflict.

A few recent empirical studies link climate change to violent conflict. Hendrix and Glaser (2007) study the determinants of civil war onset specifically in Africa between 1981 and 1999. They use two different civil war datasets by Fearon and Laitin (2003) and use the PRIO/UCDP[22] data to construct their civil war onset variable. The Global Precipitation Climatology Project (GPCP) database provides annual rainfall estimates as one measure of climate change. Fearon and Laitin's three main explanatory variables are (i) climate suitability for agriculture (using the Köppen-Geiger climate system scale), (ii) land degradation (percent of total land area degraded), (iii) and year-to-year interannual variance in rainfall (based on average annual rainfall in milliliters per

[22] Peace Research Institute Oslo (PRIO) / Uppsala Conflict Data Program (UCDP)

year). The results suggest that inter-annual variability in rainfall significantly affects the onset of civil war in Africa.

Burke et al. (2009) also focus on Africa for the period between 1981 and 2002. Their dependent variable is civil war incidence (i.e. the propensity for a country to be in a state of civil war) in country *i* in year *t*. For this variable they also utilize the PRIO/UCDP dataset. Their main contribution lies in modeling the effects of climate change on the incidence of civil conflict using both temperature *and* precipitation variables. Several specifications are proposed. Most control for lagged values of temperature and precipitation, and some include controls for per capita income and type of political regime. The results suggest that higher temperatures tend to increase the incidence of civil war. This result is robust across a variety of specifications, but the statistical significance of the coefficient on temperature diminishes to only 10% level in their most comprehensive model.

Other empirical research has analyzed much longer historical series. Zhang et al. (2006) use the data on frequency of conflict (wars and rebellions in three distinct climate regions) in China between 800 BCE and CE 1911. The climate data for the Zhang study come from Briffa and Osborn (2002) who collect and recalibrate five common climate series over the last millennium for the Northern Hemisphere. Zhang et al. then employ pair-wise correlation analysis and find that the frequency of annual, decadal and "phase level" (cold or warm) rebellions and wars tends to be correlated with the temperature anomalies associated with lowest and average temperatures, but not high temperatures. The results seem to be robust to the inclusion of temperature lags, especially at the annual level.

The results of Zhang et al. (2006) suggest that the correlation between temperatures and conflict is mostly significant for the Central China region. The authors argue that these regional differences in conflicts associated with weather conditions arise from marked local climate fluctuations. Thus, South China, endowed with subtropical and tropical climates, has a greater capacity to adopt alternative crops when climate-related shocks occur. Central China, however, is characterized by monsoon cycles. Monsoons tend to bring a cold Siberian air mass during the winter. If this cold is persistent, it can result in a much greater susceptibility of agricultural production to cold temperature shocks. The Central China region has a lower adaptive capacity in terms of alternative crop introduction (due to its more temperate climate), so wars are more likely to occur as a consequence of a sustained and atypical cold spell. In further research, Zhang et al. (2007) extend their analysis to Europe and find that the frequency of civil wars is again correlated with unusually cold spells.

Tol and Wagner (2010) likewise analyze the effects of changes in average temperature and precipitation changes on the frequency of violent conflict in Europe. For their dependent variable, the authors use data on all historically recognized violent conflicts in Europe between 1000 AD and 1990 AD, while their climate data are drawn from various reconstructions of historical average temperatures and precipitation.[23] These authors utilize regression techniques to estimate several specifications where they model the passage of time by using quadratic time trends. They also model the changing relationship between violent conflict and temperature by using interactions between time

[23] Tol and Wagner collect their European conflict data from http://www.warscholar.com/; their historical temperature data are drawn from research conducted by Luterbacher et al. (2004) and NOAA and von Storch et al. (2004); their historical precipitation data comes from research conducted by Pauling et al. (2006).

and temperature to permit temperature effects to vary systematically over time. Additional autoregressive specifications control for the number of conflicts in the previous two years with additional controls for the period of the Protestant Reformation. The results of the model with interactions suggest that conflict was more prevalent during colder periods. However, the results are not robust to alternative temperature reconstructions or to all sub-periods of the data. For example, the results imply no effect of temperature on conflict frequency during the industrialized era (from 1750 to 1990).[24] Thus the hypothesis that extended periods with poor harvests lead to violent conflict appears to hold only for earlier societies that relied more heavily on agriculture.

3.2.3. *Extreme Weather Effects on Civil War*

The main argument in this literature is that changes in patterns and frequencies of natural disasters such as droughts, storms, floods, wildfires, and periods of extreme hot or cold temperatures can create negative income shocks via their negative effects on agricultural production. Consequently, these events might decrease the opportunity cost of pursuing conflict, thus increasing the chance that conflict might arise and persist.

Research concerning the effects of different extreme weather events related to climate change (other than temperature and precipitation) on various aspects of civil wars, such as their onset, occurrence (incidence) and duration, has received even less attention. Nel and Righarts (2008) appears to be the only study that attempts to study the influence of climate-change-related disasters on civil war onset. They employ a dataset consisting of 187 political units for the period 1950-2000 and find that natural disasters significantly

[24] Autoregressive model presented in Toll and Wagner (2010) Table 6 and 7, pp.12.

increase the risk of civil violence. They identify rapid-onset geological and climate related disasters as posing the highest overall risk. These authors aggregate disasters into either “climate” or “geological” groups, so the study has not answered the question about which specific types of disaster events have the greatest tendency to precipitate a civil war. This is an important question to address, since appropriate mitigation or adaptation policies will differ by the type of a disaster. The present paper thus extends Nel and Righarts (2008) by distinguishing and controlling for specific types of events such as: droughts, extreme temperatures, epidemics, floods, storms and wildfires.

Besley et al. (2009) develop a theoretical model for current civil war status (incidence) over time and accross countries and test it empirically. This appears to be the only paper that attempts to measures the impact of climate-change-related disasters on civil war incidence. They use an OLS specification and add time and year fixed effects to control for unobserved heterogeneity related to each country’s unique cultural and institutional characteristics. They include an aggregate measure of “weather shock” and find that it has a positive impact on a country’s civil war status (incidence). They construct their weather shock variable by aggregating floods and extreme heat events into a single measure. I extend the Besley et al. (2009) paper by disaggregating, to look into the effects of individual disaster types on civil war status.

Fearon (2004) appears to be the only published paper that explores the determinants of civil war duration. Civil war duration is defined as the number of years it takes for the conflict to finish. This is different than civil war incidence, which is the occurrence of conflict in country *i* in year *t*. I am not aware of any papers that have attempted to study the effects of natural disasters or any other measure of climate change on civil war duration.

3.2.4. *Environmental Conflict and Security Literature*

In addition to aforementioned quantitative conflict literature there is a much older and well established qualitative literature on environment and security. Homer-Dixon (1994) analyzes several case studies and identifies causal links between conflict and environmental degradation. He suggests that environmental scarcity causes conflict that tends to occur at a sub-national level and tends to be persistent. Scarcities in water, forest and agricultural resources are identified as major sources of environmental conflict. Climate change is argued to have an effect as well, but not in its own right, but through interactions with the mentioned resources. The author also argues that population pressures as well as unequal resource distribution contribute to the incidence of environmental conflict.

Homer-Dixon (1991) describes three theoretical perspectives on conflict: frustration-aggression theories, group-identity theories and structural theories. In the first case the conflict is argued to arise from individuals' frustrations with an entity that they perceive is obstructing them from reaching their goals. Group-identity theories approach the issue from the perspective of social psychology and focus on ethnicity, nationality and religious issues as major causes of conflict. Structural theories are consistent with economics approach to conflict. These theories stress that conflict arises from calculations made by rational actors facing external constraints. Based on the three approaches Homer-Dixon hypothesizes that environmental degradation produces three types of conflicts: simple scarcity conflicts, group identity conflicts and relative-deprivation conflicts. The first type is best explained by structural theories and suggests that conflict arises from key resource scarcity. Author provides an example case in support of this perspective. It involves water access issues between Turkey and Syria whereas Turkey's plans to build massive system of dams and irrigation canals on the Euphrates have come at a cost to water deprived Syria. This, in turn, is suggested to fuel internal civil war in Turkey, between the government and the Kurdish insurgents acting as a proxy for Syria on the issue.

Levy (1995) provides a different perspective on the issue of environment as a national security issue. He argues that much of the concern voiced by many researchers is more of an artifact of time when these studies have been written and the general attention environmental issues have received since the 1980s, than an actual concern that environmental issues could cause conflict. In other words, the author suggests that even is environmental issues affect national security they are of little importance. He points to previous conflict literature that fails to mention environmental issues as a potential national security issue. He does acknowledge that the only environmental degradation cases that might matter are ozone depletion and climate change. Finally, Levy argues that it is better to deepen the understanding of other causes of individual conflicts, endemic to each case, than to focus on smaller causes, such as the environmental degradation.

Several recent studies have summarized major perspectives on environment and security. Khagram and Ali (2006) discuss the differences between two perspectives on environmental conflict: environmental scarcity and environmental abundance theories. Environmental scarcity theories suggest that scarcity can be induced by supply factors such as degradation of natural resources; demand factors, such as increased consumption; and structural factors, such as unequal distribution of resources. The main empirical finding in this literature suggests that environmental scarcity causes civil strife, but not international conflict. Environmental abundance literature, on the other hand, proposes another pathway for conflict. In this case, it is the relative abundance of resources, most often in mineral resource sectors, that causes conflict. Furthermore, conflicts arising from resource abundance tend to be short lived and end in a military defeat of one of the parties in the conflict. Authors conclude that more empirical research is needed to resolve this issue. Furthermore, they advocate moving from anecdotal evidence provided by much of the earlier research to more rigorous empirical work.

Detraz and Betsill (2009) analyze how environmental conflict and environmental security perspectives are adopted by the 2007 United Nations security debate on security aspects of climate change. Environmental conflict perspective is based on the resource scarcity approach as a major source of conflict. Environmental security literature, on the other hand, takes a broader perspective and is more concerned with impact on all of humanity, as opposed to focusing on the state. The aforementioned United Nations security debate is said to be more reliant on the environmental security perspective.

3.3. Data

Like several other researchers, I also use the civil war database constructed by Fearon and Laitin (2003) as a source for dependent variables: civil war onset and status.[25] A conflict in a particular country is coded as a civil war if the following three selection criteria are satisfied:

(1) the conflict involves fighting between agents of (or claimants to) a state and organized, nonstate groups who seek either to take control of a government, to take power in a region, or to use violence to change government policies;

(2) the conflict kills at least 1,000 people in total over its course, with a yearly average of at least 100 conflict-related deaths;

(3) at least 100 people are killed on each side (including civilians attacked by rebels (Fearon & Laitin, 2003).

There are 6278 country-year observations in the sample and the rate of conflict is 1.67 per 100 country years. Civil war duration data are described in Fearon (2004).[26]

The climate and weather-related disaster data come from a global database on natural and technological disasters called EM-DAT.[27] This database contains disaster-level data on some 18,000 disasters that have occurred since 1900. The database is maintained by the Centre for Research on the Epidemiology of Disasters (CRED) at the School of Public Health of the Université Catholique de Louvain, Belgium. The data are

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[25] Fearon and Laitin were inclined to construct their own database to correct for certain types of exclusions in other existing databases. Their data are available for downloading at http://www.stanford.edu/~jfearon/data/apsr07repdata.zip

[26] Data available at http://www.stanford.edu/~jfearon/data/jprrepdata.zip

[27] Available at http://www.emdat.be/

compiled from various sources including national governments, UN agencies, and other non-governmental organizations (such as the Red Cross). The selection criterion for disasters requires 10 or more people to die in a given disaster, and 100 or more people to be affected by it, a declaration of a state of emergency and a call for international assistance. The database is updated daily with all new disasters satisfying the aforementioned criteria.

For the purposes of this study I utilize the available meteorological data from the EM-DAT database on storms; hydrological data on floods; climatological data on extreme temperatures (low and high), drought and wildfire; and epidemiological data on severe outbreaks of disease. Furthermore, I aggregate the EM-DAT disaster data to country-by-year disaster counts. Summary statistics are presented in Table 1. Note that the average incidence of a given type of disaster is low. Floods occur at the highest average rate of 0.267 per country-year, while extremely hot temperatures (caused primarily by heat waves) take place at rate of only thousand country-years in the data.

The remaining control variables for civil war onset and incidence come from Fearon and Laitin (2003) as well as some additional sources. The measure of "mountainous terrain" is constructed by A. J. Gerrard for the World Bank DECRG project on civil wars. Income per capita comes from the Penn World Tables. Population data come from the World Bank's World Development Indicators (WDI). The so-called Polity IV regime index is a commonly used indicator of political authority. [28] The regime authority spectrum ranges from -10 for a hereditary monarchy to +10 for a consolidated democracy. In the analysis, I use a dummy variable indicating whether the country had a

[28] Available at http://www.systemicpeace.org/polity/polity4.htm

three-or-greater change on the Polity IV regime index in any of the three years prior to the year in question, as do Fearon and Laitin (2003). Countries with mixed democratic and authocratic characteristics, often called anocracies, are included by constructing an indicator that equals 1 if the Polity IV score ranges between -5 and 5, and 0 otherwise, per Fearon and Laitin (2003). Oil exports are obtained from the World Bank's World Development Indicators (WDI) and are included by constructing an indicator for when fuel exports exceed one-third of export revenues. Fearon and Laitin (2003) constructed variables for prior wars, noncontiguous territories (i.e. when a part of the country is physically separated from the "mainland") and new states themselves.

Summary statistics are provided for civil war onset and incidence models in Table 1. They suggest that civil wars occur in some 15% of country-years. Table 2 provides correlations between different types of environmental disasters and Table 3 presents further evidence of multicollinearity between these disasters.

Table 1. Summary Statistics for Civil War Onset and Incidence Models (n=6278 country-years, from 1945 to 1999)

Variable	Mean	Std. Dev.	Min	Max
Dependent variables:				
1(Civil_War_Onset)	0.0167	0.128	--	--
1(Civil_War_in_Progress)	0.147	0.354	--	--
Additional conflict variable				
Prior war	0.132	0.339		
Counts of climate-related natural disasters				
Drought_t	0.0908	0.293	0	2
Extreme Cold_t	0.0141	0.130	0	2
Extreme Heat_t	0.0103	0.107	0	2
Epidemic_t	0.0943	0.397	0	6
Flood_t	0.277	0.757	0	14
Storm_t	0.269	1.13	0	27
Wildfire_t	0.0251	0.184	0	4
Prior war	0.133	0.340	--	--
Sociodemographic, geographic, and political controls				
GDP/capita, lagged	3.66	4.54	0.048	66.7
log($\text{Population Density}_t$)	-3.38	1.54	-14.4	1.55
log(% mountains)	2.17	1.40	0	4.55
1(Noncontiguous state)	0.173	0.379	0	1
1(Oil producer)	0.129	0.336	0	1
1(New State)	0.0294	0.169	0	1
1(Instability)	0.146	0.354	0	1
PolityIV	-0.472	7.52	-10	10
1(Anocracy)	0.223	0.416	0	1

Table 2. Correlation Matrix for All Disaster Events in Civil War Onset and Incidence Models, 1945-1999 (n=6278)

	Drought	Extreme Cold	Extreme Heat	Epidemic	Flood	Storm	Wildfire
Drought	1						
Extreme Cold	0.0459	1					
Extreme Heat	0.0427	0.1203	1				
Epidemic	0.0951	0.1007	0.0917	1			
Flood	0.1311	0.1698	0.1748	0.1965	1		
Storm	0.0866	0.1575	0.2166	0.0711	0.4233	1	
Wildfire	0.0676	0.0803	0.1026	0.0863	0.1726	0.3016	1

Table 3. Tolerance for Each Event in All Disasters Civil War Onset and Incidence Models

Variable	R^2
Drought	0.024879
Extreme Cold	0.048792
Extreme Heat	0.065269
Epidemic	0.054179
Flood	0.226041
Storm	0.25512
Wildfire	0.099035

For the civil war duration models, variables coded by Fearon (2004) are used for coups and revolutions, colonial wars, the presence of indigenous populations (sons of the soil) fighting migrants to their areas, and contraband-related financing of war. Summary statistics for duration data and corresponding controls are displayed in Table 4. Table 5 provides correlations between different types of environmental disasters and Table 6 presents further evidence of multicollinearity between these disasters.

Table 4 . Summary Statistics for Civil War Duration Models (n=1102 country-years, from 1945 to 1999)

Variable	Mean	Std.	Min	Max
Dependent variable:				
Civil War Finishes	0.0826	0.2750	--	--
Counts of climate-related natural disasters:				
Drought	0.178	0.398	0	2
Extreme Cold	0.046	0.251	0	2
Extreme Heat	0.027	0.178	0	2
Epidemic	0.285	0.731	0	6
Flood	0.758	1.34	0	8
Storm	0.616	1.59	0	11
Wildfire	0.033	0.182	0	2
Sociodemographic, geographic, and political controls				
1(Coup/revolution)	0.0515	0.221	--	--
1(Eastern Europe)	0.0352	0.184	--	--
1(Not contiguous)	0.190	0.392	--	--
1(Sons of the soil)	0.302	0.459	--	--
1(Contraband)	0.256	0.436	--	--
GDP/capita (lagged, in 1000s)	1.93	2.07	0.0500	14.9
log(Population Density$_t$)	-3.00	1.270	-5.98	-0.0674
Democracy (–10 to 10, lagged)	-0.498	6.77	-10	10

Table 5. Correlation Matrix for All Disaster Events in Duration Models, 1945-1999 (n=1102)

	Drought	Extreme Cold	Extreme Heat	Epidemic	Flood	Storm	Wildfire
Drought	1						
Extreme Cold	-0.0113	1					
Extreme Heat	0.0552	0.1294	1				
Epidemic	0.0241	0.1971	0.2505	1			
Flood	0.1116	0.267	0.2363	0.3034	1		
Storm	0.1213	0.2149	0.1448	0.1277	0.4608	1	
Wildfire	0.029	0.0828	0.0268	0.3326	0.1037	0.0338	1

Table 6. Tolerance for Each Event in All Disasters Duration Models

Variable	R^2
Drought	0.0229286
Extreme Cold	0.0992429
Extreme Heat	0.1018733
Epidemic	0.226383
Flood	0.3051134
Storm	0.2287929
Wildfire	0.1153389

3.4. <u>Econometric Specification</u>

3.4.1. *Civil War Onset*

To model the determinants of civil war onset, I propose the following logit discrete outcome econometric specification analogous to those common in the conflict literature,

$$\text{Model O1: Civil\_War\_Onset}_{\text{it}} = \beta_0 + \beta_1 \text{Disaster}_{\text{it}} + \sum \beta \text{X}_{it} + \varepsilon_{it} \tag{1}$$

The dependent variable *Civil_War_Onset*$_{it}$ is a binary variable equal to 1 if a civil war starts in a country i in year t, and 0 otherwise. *Disaster*$_{it}$ is the frequency of one given given type of disaster in country i in year t. These disasters are: droughts, epidemics, extreme cold temperatures, extreme hot temperatures, floods, storms and wildfires.

Across a sequence of analogous specifications, I rotate through this list of disaster types, featuring one type of disaster at a time. Vector X_{it} contains the following control variables: occurrence of civil war in the previous year, income per capita lagged one year (thousands of 1985 U.S. dollars), the logarithm of the population density also lagged one year, the logarithm of the percent of the country's terrain classified as "mountainous." an indicator for states with noncontiguous territories, an indicator for whether this is an oil-producing country, an indicator for a newly formed state (such as countries formed after dissolution of the Soviet Union), an index of political instability (Polity IV), indicator for whether the country is in the state called "anocracy". Possible endogeneity of the GDP per capita variable is addressed by using the lagged values of these variables instead of the contemporaneous ones. Again, this list of auxiliary variables is fairly standard in the literature for the determinants of civil war onset and has been used in previous research, most prominently by Fearon and Laitin (2003).

As measures of climate change, the majority of the previous literature has tended to use only average temperature and precipitation. These variables are constructed from "projection and reconstruction" raster data to produce aforementioned variables.[29] A contribution of this paper is the extension of the model to include individual discrete counts of an array of natural disasters as a measure of climate change. Climate change is likely to be manifested in a wide variety of weather-related phenomena beyond just temperature and precipitation changes, such as an increased frequency of natural disasters like droughts, epidemics, extreme cold and hot temperatures, floods, storms and wildfires.

[29] Meteorologists produce historical climatological data by dividing the globe into a grid consisting of equal size areas. These areas do not fit country borders, so interpolation is necessary to produce country level data.

As a robustness check, the basic specification in equation (1) is expanded by introducing up to three annual lags for each of the pertinent disaster frequencies. Furthermore, I consider alternative specifications with time fixed effects, to control for the impacts, common to all countries that vary by year. Such a generalization seems warranted since it is plausible that some time periods have unique common effects (for example, the colonial wars for independence that characterized the first few decades of the sample). Time fixed effects may be particularly important in this application, since natural disasters are more likely to have gone unreported earlier in the sample period and time fixed effects may control for this to a certain extent.[30]

Another possible specification is to include all the different type of disasters simultaneously as explanatory variables in the same specification. Such a model, however, may have difficulty in discriminating between the effects of different types of disasters if these have tended to covary, as may be the case for storms and floods.

Thus the kind of specification where we are most likely to discern the effect of one type of disaster includes time fixed effects as well as varying degrees lagged effects[31],

$$\text{Model O8}:\text{Civil\_War\_Onset}_{\text{it}} = \beta_0 + \sum_{s=0}^{3}\beta\text{Disaster}_{\text{it-s}} + \sum\beta\text{X}_{it} + \delta_t + \varepsilon_{it} \qquad (2)$$

where δ_t are the time fixed effects, and $Disaster_{it\text{-}s}$ is the frequency of a given disaster in country *i* at time *t-s.*

[30] Burke et al.(2009), for example, use country specific time trends to control for variables that evolve over time. This would not be applicable in this case, since natural disaster measurement problems (i.e. potential omission of events during earlier periods) require time fixed effects, not trends. Despite this, I have estimated models with country specific time trends and found no significant differences relative to the model with time fixed effects.

[31] The logic for the labeling of these models will be explained in the appendix section. Intermediate models O2 through O7 are also estimated.

When it comes to control variables countries with higher incomes and prior wars are expected to be systematically less likely to experience the onset of a civil war. The former variable acts as a proxy for government strength relative to that of insurgents. Each of the remaining controls is expected to have a positive effect on the probability of onset of a civil war. Specifically, a greater population density induces greater competition for scarce resources and thus increases the chance that such competition will turn violent within the country. Mountainous terrain makes the country harder to govern, since insurgents could more easily take advantage of the protection afforded by harder-to-access terrain to develop and cultivate their insurgency against the government.

Oil exporting countries tend to have less well-developed bureaucracies, since they do not have as much of a necessity to raise tax revenues from the local population to pay for the services of government. A weaker state thus increases the chance that someone will try to topple it. The"weaker state" argument also applies to new states, unstable states, noncontiguous states and anocracies.

The main pathway by which climate change affects civil war onset is hypothesized to be through negative shocks to agricultural production. Such shocks increase food prices, depress income, and consequently decrease the opportunity cost of pursuing violent conflict as a means of resolving resource competition between groups. Droughts, extreme hot and cold temperatures, floods, storms and wildfires all affect agricultural production to varying degrees. Thus it is expected that they will tend to increase the probability of civil war onset. Moreover, events such as droughts and extreme hot and cold temperatures are expected to have a more discernable effect on civil war onset since they tend to affect wider areas than do more localized disaster events such as storms, floods and wildfires.

In addition to estimating the aforementioned models using a simple binary logit estimator, I also estimate them using a simple linear probability model (with country and year fixed effects). This model's results should be interpreted with caution, of course, since linear probability models are often fraught with heteroskedasticity issues, likely making the regression coefficients inefficient. Furthermore, I estimate all of the proposed models using the conditional (fixed effects) logit model, employing both country and year fixed effects. The downside of using this estimation method is that it drops all countries that do not experience onset of civil war in the sample. It would do the same for all countries that experience onset of civil war every year in the sample. Thus when there is no variation in the dependent variable for a given country in the sample, this country's contribution to the log-likelihood is zero and as such they have no effect on the estimation. Thus the sample becomes restricted to countries that experienced civil war onset in some years, but not in all years, effectively reducing the sample from 154 to 64 countries and from 6,278 country-year pairs (observations) to only 2,736. Thus the results should be interpreted with caution.

3.4.2. *Civil War-in-Progress*

Civil war incidence is different from civil war onset. The onset variable takes the value of 1 only in the year the conflict starts. The incidence variable takes on a value of 1 in any year conflict is occurring. I model the determinants of civil war incidence utilizing a commonly used logistic specification in conflict literature,

$$\text{Model P1: Civil\_War\_in\_Progress}_{\text{it}} = \beta_0 + \beta_1 \text{Disaster}_{\text{it}} + \sum \beta \text{X}_{it} + \varepsilon_{it} \tag{3}$$

where the dependent variable *Civil_War_in_Progress*$_{it}$ is a binary variable equal to 1 if a civil war is under way in country *i* at year *t*, and 0 otherwise. *Disaster*$_{it}$ is the frequency of a given disaster type in country *i* in year *t*. Included disasters are again: droughts, extreme cold temperatures, extreme hot temperatures, epidemics, floods, storms and wildfires. I use identical X_{it} controls (other than "prior war" variable) in the *Civil_War_in_Progress*$_{it}$ model as in the previous *Civil_War_Onset*$_{it}$ specifications.

As a robustness check, the specification in equation (3) is also expanded by introducing up to three lags for pertinent disaster frequencies. Furthermore, again I consider alternative specifications with time fixed effects to control for impacts common to all countries that vary by year. I include all the disasters as explanatory variables at the same time in another alternative specification.

Thus the most general specification includes time fixed effects as well as varying degrees lagged effects,

$$\text{Model P8: Civil\_War\_in\_Progress}_{\text{it}} = \beta_0 + \sum_{s=0}^{3} \beta \text{Disaster}_{\text{it-s}} + \sum \beta \text{X}_{it} + \delta_t + \varepsilon_{it} \tag{4}$$

where δ_t are the time fixed effects, and *Disaster*$_{it\text{-}s}$ is the frequency of a given disaster in country *i* at time *t-s*. Again, I also estimate these models using the linear probability model and conditional (fixed effects) logit model, employing both country and year fixed effects in both specifications.

3.4.3. *Civil War Duration*

I model civil war duration in a discrete-time framework using several common parametric and non-parametric survival models. Previous researchers have not modeled civil war durations in discrete-time framework. Most common approach is to use non-time varying variables, whose values are measured only at the start of the event whose duration is measured. In contrast, I do allow climate-change-related disasters to vary over the duration of a war.

I test the impacts of various disaster events on civil war duration under different assumptions about the hazard function. I explore a semiparametric Cox proportional hazards model, as well as Exponential, Weibull and Gompertz specifications, as well as a discrete time proportional hazards model (Prentice-Gloeckler, 1978) and logistic regression models. The Cox proportional hazards model is the most flexible with respect to the nature of any form of duration dependence, since the component of the hazard function that captures duration dependence cancels out and need not be specified explicitly, whatever it is. The exponential duration distribution has a constant hazard rate, which is often considered too restrictive of an assumption. The Weibull and Gompertz forms have a flexible hazard function that can that monotonically increase or decrease (Cameron and Trivedi, 2005). The Prentice-Gloeckler grouped duration data proportional hazards regression model is especially appropriate when the timing of the event of interest is not observed exactly but is only known to occur within some specified time interval.

The dependent variable in these models is civil war duration. The main regressors of interest are the frequencies of annual climate-change-related disaster events. Disaster events are modeled as time-varying covariates. Thus they are included in each model by accounting for the frequency of each type of event for every year during which a given civil war is in progress. While Fearon (2004) does not include any weather related variables, I follow his lead in terms of other types of control variables to include in the model. Control variables are taken from the influential work on civil war duration by Fearon (2004). These include: a binary variable for coups and revolution (measured at start time), another for Eastern Europe (non-time varying covariate), colonial wars (a non-time varying covariate), the presence of indigenous populations ("sons of the soil"), fighting migrants to their areas (a non-time varying covariate), contraband related financing of war(non-time varying covariate), logarithmically transformed population density (a time-varying covariate), lagged GDP/capita (a time-varying covariate) and PolityIV measure of the level of democracy (a time-varying covariate).

Disaster events are expected to increase the expected duration of civil wars (i.e. to reduce the "hazard" of a civil war coming to an end). The pathway by which these events are hypothesized to impact civil war duration is similar to that in the models for $Civil\_War\_Onset_{it}$ and $Civil\_War\_Progress_{it}$ cases. As argued in other cases, disaster events decrease the opportunity costs of using violent conflict as a method to assert power over allocation of scarce resources. The most profound effect of a disaster on civil war duration is expected to come from an event that can keep such opportunity costs low for the duration of the war. This is more likely to be the case with persistent climate-related problems. Long-lasting tendencies, as opposed to one-time events such as local or regional severe storms, are more likely to have discernable effects on civil war durations.

In terms of the control variables, successful coups and revolutions as the provocation for a civil war are expected to shorten the duration of a civil war. Coups are defined as attempts by individuals and groups associated with a government (for example, a faction within the military) to use violence against their government (for example, parliament) in an attempt to seize power. Coups tend to be brief, as there tends to be little underlying support for the goals of an average coup. Revolutions also tend to be brief, as they are characterized by a large groundswell of anti-government sentiment that often unites large portions of society in a common cause. An indicator variable for Eastern Europe controls for the collection of brief civil wars that took place in that region as a part of a transition from socialism to democracy. Similarly, an indicator for anti-colonial wars is included to control for a wars of independence from colonial powers.

Controlling for colonial independence is important since a significant proportion of wars in the 1950s and 1960s were colonial wars. These tended to be brief, since colonial powers tended to be too far away from the locale of the uprising to successfully stop them. Furthermore, colonial powers had to deal with many such uprisings at the same time, spreading their resources thin. "Sons of soil" wars are expected to last longer because they involve an organized group within a country (often ethnic) that opposes in-migration by other groups. Since the insurgents are living within the country and control an area, it is less likely that the insurgents would be quickly dealt with.

Other variables include the existence of significant illegal drug production and trade. Active drug production and trade is expected to increase civil war durations, since these activities provide valuable access to money for the insurgents. Incomes should have a negative impact on civil war durations, since higher income increases the opportunity cost of pursuing violence. Similarly, a higher level of democracy achieved by a given country is expected to shorten the length of a civil war because such countries have institutions that may deal with any grievances more effectively than non-democratic countries. Bleaney and Dimico (2011) provide support for use of different covariates in civil war duration and onset models.

3.5. Empirical Results

3.5.1. *Civil War Onset*

For each disaster, I estimate eight models. I start with the specification in equation (1), which I call model O1, and then add lags to this model until there are three lagged disaster terms (i.e. in model O4). Then I add time fixed effects to equation (1), and call it model O5. After adding up to three lagged disaster terms to this model I end up with the specification featured in equation (2), and call this model O8[32]. The complete sets of parameter estimates for all models are presented in Appendix A, Tables A1 through A8.

Since the complete set of results is so voluminous, I will focus on just the key estimated coefficients in the body of this paper. A summary of estimated results from specifications which feature just individual disaster models are presented in Table 7, while the results from a model where all of the disaster effects estimated simultaneously are presented in Table 8. Only the significant coefficients on the disaster variables are summarized in these tables. The first "Significant Coefficients" column shows the ranges of point estimates for the coefficients for which statistical significance is attained for all individual disaster event models without time fixed effects. The "Models" column in

[32] See Appendix A, Table A0.

Tables 7 and 8 provides information about the types of models in which the coefficient on a particular type of a disaster event frequency is significant.

In Table 7, each different row presents estimated coefficients from distinct models associated with just a single type of disaster. For example, Table 7 reports that the coefficient on the Extreme Heat$_{t-2}$ variable is statistically significant at the 10% level only in the model O3 that includes two lags for Extreme Heat. The coefficient on Extreme Cold$_t$, on the other hand, is significant in models with O1 through O4. The second "Significant Coefficients" column shows the estimated coefficients, for all individual disaster event models with time fixed effects, which are individually statistically significant. The second "Models" Lags column again provides information about the types of models with time fixed effects in which the coefficient on a particular type of a disaster event frequency is significant.

Table 7. Determinants of Civil War Onset : Significant Coefficients from Individual Event Panel Logit Models, 1945-1999 (n=6278)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
Drought$_{t-1}$	0.589*	O3	--	--
Extreme Cold$_t$	1.226** to 1.438***	O1,O2,O3,O4	1.209*** to 1.381***	O5,O6,O7,O8
Extreme Heat$_{t-1}$	1.098* to 1.427**	O2,O3,O4	1.273* to 1.581**	O6,O8
Extreme Heat$_{t-2}$	1.091*	O3	--	--
Extreme Heat$_{t-3}$	1.102*	O4	1.135*	O8
Epidemic$_t$	0.299* to 0.380**	O1,O2,O3,O4	0.346* to 0.379**	O5,O6,O7,O8
Storm$_{t-2}$	0.235* to 0.316**	O3,O4	0.353*	O8
Storm$_{t-3}$	--	--	-0.511*	O8
Wildfire$_t$	1.125** to 1.247***	O1,O2,O3,O4	1.133** to 1.234**	O5,O6,O7,O8
Control Variables	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix A Tables A1 through A7. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 8. Determinants of Civil War Onset : Significant Coefficients from All Events Panel Logit Models, 1945-1999 (n=6278)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
$Drought_{t-2}$	--	--	-0.862*	O7
Extreme $Cold_t$	0.913* to 1.205***	O1,O2,O4	0.949* to 1.226***	O5,O6,O8
Extreme $Heat_{t-1}$	--	--	1.400*	O8
$Epidemic_t$	0.300*	O1	0.345* to 0.391*	O5,O6,O7,O8
$Storm_{t-2}$	0.358**	O4	0.417**	O8
$Storm_{t-3}$	-0.478*	O4	-0.624**	O8
Control Variables	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix A Table A8. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 8 has the same format as Table 7, but shows significant coefficient estimates for a model that includes all disaster events. As previously mentioned, such model might suffer from multicollinearity. Table 2 presents pair-wise correlation matrix between disaster events and Table 3 presents R^2 for regressions where a given disaster is a dependent variable determined by the remaining disasters. These statistics suggest that multicollinearity is not severe.

The most striking and least ambiguous finding among the estimated results is that the frequency of contemporaneous extreme cold events (Table 7 and Table 8) has a positive and significant effect on the onset of civil war. The estimates are robust across specifications, being significant at the 5% level ot better in all specifications. Similar studies focusing only on incidence of civil war have found similar effects, so these result represent a reassuring confirmation of earlier results. Zhang et al. (2006) attribute the observed effect to a negative shock that agricultural production experiences as a consequence of lower temperatures. This leads to decreased incomes, and lowers the opportunity cost of conflict as a manifestation of competition over scarce food resources (implying higher food prices). In contrast to the findings of Toll however, my estimates suggest that these connections have not been broken in the modern era.

Interestingly, another type of natural disaster is also found to have an effect on the probability of civil war onset, in both individual disaster (Table 7) and all-disaster models (Table 8). This is the contemporaneous frequency of epidemic outbreaks. Although epidemics affect incomes, there are other pathways by which epidemics increase the probability of a civil war. An area affected by an epidemic is simply more vulnerable to attacks, since its inhabitants, weakened by the disease, are unable to fend off their attackers (assuming these attackers are unaffected, or at least less affected, by this disease).

Contemporaneous and lagged frequencies of droughts, extreme heat events, floods, and storms seem to have no persistently significant effects on the probability of civil war onset. There are, however, a few instances that suggest some possible evidence of disaster impacts, though not robustly so. For example, in Tables 7 and 8, a single lag of extreme heat events also seems to increase the probability of civil war onset. Storms occurring two years earlier may have a positive impact on the probability of civil war onset. On the other hand, storms taking place three years earlier may have a negative impact on the probability of civil war onset. These results, if true, suggest that if a country can get past the two-year hurdle after the storm it is safer from civil war. Storms which inflict major damage require that the government expend significant resources on recovery and rebuilding. Oftentimes, the military is used for these purposes. This, in turn, is likely to weaken the government and invite insurgents to attack. Since it takes some time to rebuild and recover, the government may be vulnerable for at least two years.

As a robustness check, I also estimate conditional (fixed effects) logit models and fixed effects linear probability models. These are presented in the Appendix in sections B and C, respectively[33]. The cost of using conditional (fixed effects) logit model is a loss of the majority of observations. The final model is restricted in that it uses only 2736 observations associated with all countries and years in which there is a civil war. The coefficient estimates do lose some significance compared to the random effects logit model, but most of the relations persist. The coefficient estimates on extreme cold events and epidemic outbreaks are consistent with the original panel logit model. In this model, however, additional disasters come to matter. In particular, contemporary extreme heat events seem to be, counter intuitively, negatively related to the probability of civil war onset. Epidemic outbreaks, however, don't seem to have any effects on the probability of civil war onset in these specifications. The fixed effects linear probability models may suffer from heteroskedasticity, however[34].

3.5.2. *Civil War-in-Progress*

As in the civil war onset models I estimate eight models. But now, I estimate equation (3), which I call model P1. P1 with an additional lag is P2, while P1 with two lags is P3, and finally P4 has three lags. P1 with time fixed effects is P5; P2 with time

[33] See Table B9 for the summary of the individual-disaster model results and B10 for the summary of the all-disaster models estimated using conditional (fixed effects) logit models. See Table C9 for the summary of the individual-disaster model results and C10 for the summary of the all-disaster models estimated using fixed effects linear probability models.

[34] I also estimate the linear probability model using robust standard errors, and find the results to be consistent with those of previous specifications. I also performed additional robustness checks whereby I drop all new countries entering the sample, and find the results to be similar to those of the 'full' models.

fixed effects is P6; P3 with time fixed effects is P7; and P4 with time fixed effects is P8[35]. The complete sets of parameter estimates for all models are presented in Appendix D Tables D1 through D8.

A summary of estimated results from individual-disaster models is presented in Table 9, and the all-disasters model in Table 10. Estimated results suggest that all three lags of extreme heat events increase the probability of civil war in both the individual-disaster and the all-disaster models. Extreme heat events can be characterized as another type of a negative shock to incomes that also decreases the opportunity cost of pursuing violent conflict as means of competing for scarce resources. The results tend to be significant at 10% level for extreme heat events occurring one year prior to any given year in which a civil war is in progress. Second and third lags of extreme heat events bear coefficients which are significant at 5% level. The results persist when all other events are included in the model. No other disaster events seem to have this robust an effect on civil war incidence.

Again, I estimate a conditional (fixed effects) logit model and fixed effects linear probability models.[36] In the first case, I find that second and third lags of extreme heat events increase the chance that a civil war is occurring in a give country in a given year. However, the result is not present for the first lag of extreme heat events. In the linear probability models, I find that the coefficients on the lags of extreme heat events are not significant. Again, another variable seems to have an effect, in this case, the count of

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[35] See Appendix D, Table D0.

[36] See Table E9 for the summary of the individual-disaster model results and E10 for the summary of all-disaster models estimated using a conditional (fixed effects) logit model. See Table F9 for the summary of the individual-disaster model results and F10 for the summary of the all-disaster models estimated using fixed effects linear probability model.

flood events and all of its lags. These variables have a positive effect on the probability that the civil war is in progress[37].

Table 9. Determinants of Civil War Incidence : Significant Coefficients from Individual Event Panel Logit Models, 1945-1999 (n=6278)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
Extreme Cold$_t$	0.94** to 1.159***	P1,P2,P3,P4	--	--
Extreme Heat$_{t-1}$	1.008* to 1.029*	P2,P3,P4	1.003* to 1.053*	P6,P7,P8
Extreme Heat$_{t-2}$	1.526*** to 1.543***	P3,P4	1.511*** to 1.564***	P7,P8
Extreme Heat$_{t-3}$	1.265**	P4	1.193***	P8
Flood$_t$	0.152* to 0.218***	P1,P2,P3	--	--
Flood$_{t-1}$	0.139* to 0.169**	P2,P3	--	--
Flood$_{t-3}$	0.164*	P4	--	--
Storm$_t$	0.142**	P1	--	--
Control Variables	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix D Tables D1 through D7. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 10. Determinants of Civil War Incidence : Significant Coefficients from All Events Panel Logit Models, 1945-1999 (n=6278)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
Extreme Cold$_t$	0.797* to 0.951**	P1,P2,P3,P4	--	--
Extreme Heat$_{t-1}$	--	--	1.022* to 1.06*	P6,P7,P8
Extreme Heat$_{t-2}$	1.489** to 1.501**	P3,P4	1.601*** to 1.627***	P7,P8
Extreme Heat$_{t-3}$	1.181*	P4	1.258**	P8
Flood$_t$	0.152* to 0.218***	P1,P2,P3	--	--
Flood$_{t-1}$	0.165**	P1	--	--
Control Variables	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix D Table D8. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

[37] I also estimate the linear probability model using robust standard errors, and find the results to be consistent with those of previous specifications. I also performed additional robustness checks whereby I drop all new countries entering the sample, and find the results to be similar to those of the 'full' models.

3.5.3. *Civil War Duration*

Selected results from a set of select civil war duration models are presented in Tables 11 and 12. The complete estimates models are presented in Appendix G, Tables G2 through G9. Each of these tables presents results from a progression of six different non-parametric and parametric survival models. The first column in each table gives the results from the semi-parametric Cox proportional hazards model; the second column contains estimated coefficients from the parametric exponential survival model; the third column, the Weibull model; the fourth column the Gompertz model; the fifth column, the discrete time proportional hazards model (Prentice-Gloeckler, 1978); and column six gives the results from a logistic regression. I estimate these various different survival models to see how the estimates differ under different assumptions regarding the hazard function and possible duration dependence.

The estimated results suggest that civil war duration is primarily affected by drought events. The estimated coefficients tend to be significant at the 5% level across various individual-disaster specifications of these events survival models (Table 11). The drought effects also seem to be robust to the strategy of including all disaster events in a single model (Table 11).[38] No other disaster event in any model suggests a statistically significant impact on civil war duration. Droughts seem to be different than all other disaster events used in this study. Extreme cold and heat, floods, storms and wildfires can all be characterized as sudden and relatively brief (i.e. acute) disaster events. Droughts, on the other hand, tend to be "chronic events" that last much longer. Acute disasters do not seem to provide enough of a shock to agriculture, and thus incomes, to start or

[38] Tolerance and pair-wise correlation matrices suggest no serious multicollinearity issues.

perpetuate a civil war. But the persistence of droughts seems to cause enough damage to delay the end of a civil war. Sustained drought conditions probably have this effect by not allowing the opportunity costs of pursuing violent conflict to increase.

Table 11. Determinants of Civil War Duration Controlling for Frequency of Drought Events, 1945-1999 (n=1102)

Models	$Drought_t$
Cox	-0.117*
Exponential	-1.377**
Weibull	-1.485**
Gompertz	-1.415**
Discrete Time Proportional Hazards	-1.400**
Logit	-1.460**

Note: Summary of selected coefficients from Appendix G Tables G1 through G7. Only significant coefficients are presented. All six models include a full set of controls. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 12. Determinants of Civil War Duration Controlling for Frequency of All Disaster Events, 1945-1999 (n=1102)

Models	$Drought_t$
Cox	-0.128**
Exponential	-1.377**
Weibull	-1.488**
Gompertz	-1.412**
Discrete Time Proportional Hazards	-1.418**
Logit	-1.462**

Note: Summary of selected coefficients from Appendix G Table G8. Only significant coefficients are presented. All six models include a full set of controls. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

3.6. Conclusion

This study is concerned with potential climate change impacts on the potential for civil war strife. The relationship between climate and potential conflict has received increasing attention in the literature on climate change impacts and many questions remain unanswered. Recently, the IPCC and Al Gore received the Nobel Peace Price for their research on climate change, including a brief mention of climate change impacts on civil conflict. Previous research suggests that low temperatures increase the frequency of conflict frequency in Europe and China during since 1000 A.D. However, there is some evidence that these effects may have weakened during the industrialized era (Tol, 2010). Burke et al. (2009) find that higher temperatures appear to increase the probability of civil war incidence in Africa between 1981 and 2002. Thus the question remained unclear about the probable effect of on future generations.

In this paper, I have expanded the variety of climate-related events used to explain civil wars, and I have expanded the range of outcomes being considered including impacts on civil war onset, civil wars in progress, and civil war durations. As opposed to continuous measures of average temperature and cumulative precipitation, I focus on the counts of impacts of extreme events, primarily natural disasters, all of which are expected to increase in frequency due to climate change. The results point to a conclusion that societies might avoid some of the expected, and otherwise often negative, effects of natural disasters related to climate change. Although this is the case for most types of disasters, extreme cold events and epidemics seem to increase the chance for a civil war to start in countries which experience these types of shocks. I also find that the lags of severe heat waves increase the chance of a civil war being in progress in country *i* in year *t*. Finally, I find that duration of civil wars is primarily affected by droughts. Most of these effects are ascribed implicitly to a decrease in agricultural production which leads to an increase in the probability of civil war occurring due to a competition for food resources. In the near future I plan on extending the analysis by incorporating available agricultural data and empirically testing the hypothesis that these climate-change related disasters affect various measures of civil war by the way of a negative shock to agricultural production.

Understanding the policy implications of these results is important. They suggest that any proposed climate change policies should focus on mitigating the negative effects of climate change related extreme events and natural disasters, at least to the extent that this may decrease the potential for civil strife and shorten the duration of civil wars should they develop anyway. This can be achieved by appropriately funding international disaster relief programs and enabling disaster insurance programs.

CHAPTER IV

POLLUTION FROM SHIPS: DETERMINANTS OF MARPOL RATIFICATION DELAY

4.1. Introduction

Many environmental problems are global in nature and require international cooperation to counter them. International environmental agreements (IEAs) have become the primary policy instruments employed by governments concerned with these issues. Their adoption and implementation, however, is plagued by a host of political economy issues arising from public good nature of the environment, such as the incentive to "free-ride". Since IEAs are the sole instruments that countries can use to address many global environmental issues, it is important for everyone concerned to understand why and how these policies can be effectively pursued. Many IEAs, such as the Kyoto agreement, are thwarted by lack of global cooperation in resolving the relevant environmental issues. In order to overcome such an impasse, it is imperative to understand the underlying determinants of this process. Otherwise, ineffective strategies could be pursued, and environmental problems affecting the globe might not be properly addressed, increasing the costs they impose upon society.

The IEA literature points to several important factors influencing governments to adopt IEAs. These largely consist of economic and political indicators. Generally, countries with higher incomes, with more-developed institutions and more open to trade tend to be more likely to adopt IEAs. However, the current literature does not provide answers to some important questions. Are countries more severely affected by environmental problems and disasters more likely to adopt policies to mitigate them? Moreover, what is the threshold level of environmental degradation necessary for a country to adopt a relevant policy addressing it?

There are several channels by which the incidence of pollution events may lead to adoption of mitigating policies. First, individuals directly affected by the pollution are likely to demand compensation for losses and cleanup of the affected areas. Moreover, they may demand insurance against any future losses by demanding policies that prevent the potential pollution. Larger events tend to affect greater number of parties and consequently create greater demand for such policies. If the events are particularly damaging to human health and the environment, they are also likely to receive attention beyond that of the directly affected individuals. In such cases media plays a crucial role in informing citizenry about the events. Ultimately, politicians answer by supplying policies that reflect any demand for them from the population. For example, Love Canal hazardous waste site affected some thousand households in the adjacent area. However, their plight received national media attention, galvanizing the debate on the proper policies on the management of hazardous waste sites in the US. The outcome of this debate was the passage of the Superfund Act that holds polluters liable for their damages.

Marine oil spills affect coastal communities in several ways. They disrupt commercial and recreational fishing, tourism activities and shipping. They negatively affect marine flora and fauna, and upset the esthetic properties of coastal environments. Oil spills are a unique type of pollution since they primarily affect a publically owned resource, the ocean. Consequently, their prevention is in the interest of the whole nation. Exxon Valdez, the largest vessel-borne oil spill in the US history, took place in a sparsely populated area of the country. It affected only a small proportion of the fishermen in the country and disturbed remote coastline seldom visited. However, it received national media attention with images of oil contaminated beaches and wildlife coated in oil. This, in turn, raised awareness of the effects of oil pollution on public natural resources. Politicians responded by passing laws regulating financial responsibility for oil spills and liability for damages and clean up costs.

The goal of this paper is to test the hypothesis that significant pollution events act as catalysts for the adoption of mitigating policies in the IEA context. For this purpose, I conduct a case study focusing on a single multilateral IEA relating to marine oil pollution originating from ocean-going vessels, called MARPOL. I don't directly observe the level of media attention for each oil pollution event. I choose the number of oil pollution incidents and amount spilled as proxy variables for media attention. The idea is that the high frequency of oil spill incidents and large amount of oil spilled are likely to bring more media scrutiny to the issue of oil pollution.

The paper proceeds with the description of MARPOL, a literature overview, a data section, the econometric specification, and results and conclusion sections.

4.2. MARPOL

In this paper, I focus on the Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships 1973 (MARPOL 73/78), as amended (MARPOL PROT 1978 or MARPOL). This convention is an extension of an earlier treaty, the International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL). It was made available for signature at the headquarters of the International Maritime Organization (IMO) organization from 1 June 1978 to 31 May 1979 (IMO, 2010). After the signature deadline it has remained open for accession. States may become Parties to the present Protocol by: (a) signature without reservation as to ratification, acceptance or approval; or (b) signature, subject to ratification, acceptance or approval, followed by ratification, acceptance or approval; or (c) accession. Ratification, acceptance, approval or accession shall be effected by the deposit of an instrument to that effect with the Secretary-General of the Organization (IMO, pp.11).

MARPOL regulates five types of pollution originating from ships: oil discharge into the water (Annex I); carriage of noxious liquids (Annex II); storage and labeling of harmful substances (Annex III); sewage pollution (Annex IV); garbage pollution; and air pollution (Annex VI). Table 1 describes entry into force, number of countries ratified and % of the gross tonnage of the world's merchant fleet regulated under each of the Annexes.

Table 1. MARPOL Annex Descriptions

Annex	Regulating	Entry into force	Number of countries ratified	% of the gross tonnage of the world's merchant fleet
I	Oil discharge	October 2nd , 1983	150	0.9914
II	Carriage of noxious liquids	April 6th , 1987	150	0.9914
III	Storage and labeling of harmful substances	July 1st, 1992	133	0.9576
IV	Sewage pollution	September 27th, 2003	125	0.8198
V	Garbage pollution	December 31st, 1988	140	0.9745
VI	Air pollution	--	--	--

I choose MARPOL Annex I as a case study to test the hypothesis that significant pollution events act as catalysts for the adoption of mitigating policies in the IEA context for several reasons. Oil pollution from vessels is different from most pollution sources in that it enters the oceans in a series of unrelated and sometimes catastrophic events. Its effects on the environment and the economy are generally immediately observable. As such, they often garner significant media interest and consequently public and political attention (Kuran & Sunstein, 1999). This makes MARPOL a particularly fitting case to study the catalytic effect of pollution on mitigating policy adoption. Many other types of pollution, such as fertilizer runoff pollution, cannot directly be connected to a specific source. Furthermore, by March 2011, MARPOL has been ratified by 150 out 194 countries in the world. The countries that ratified it have the combined merchant fleets of 99 percent of the world gross tonnage. An overwhelming majority of countries that are the most at risk of being affected by oil spills have ratified MARPOL over the span of 32 years. So much variation allows me to identify the impact of hundreds of pollution events on MARPOL ratification delay.

4.3. Literature Overview

International agreements exist in a global policy context on a variety of economic and social issues. Some common examples include international trade agreements, such as the General Agreement on Tariffs and Trade (GATT), that regulates trade between countries (Hoekman, & Kostecki, 1999); international labor agreements that regulate labor standards, such as the prevention of child labor (Boockmann, 2001); establishment of international institutions, such as the Rome Statute of the International Criminal Court. In this paper I focus on IEAs, which are defined as “intergovernmental documents intended as legally binding with a primary stated purpose of preventing or managing human impacts on natural resources, legally binding intergovernmental efforts directed at reducing human impacts on the environment" (Mitchell, 2003, p.432). Mitchell (2003) provides an extensive literature review on IEAs. Currently IEAs address many transboundary environmental issues. For example, atmospheric pollution is regulated on an international level with Montreal Protocol on Substances That Deplete the Ozone Layer, and by the Framework Convention on Climate Change, amongst others; living organisms are protected by the Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES); some hazardous substances are limited by the Basel and Rotterdam conventions; nuclear safety is addressed by the Convention on Nuclear Safety; and marine environments are protected by MARPOL, amongst others (Chambers, 2008; Degarmo,2005; Mitchell, 2003).

Given the recent proliferation of IEAs and their importance in mitigating many global environmental problems, there has been surprisingly little research done to explain the determinants of their adoption in a quantitative framework. Fredriksson et al. (2000) is amongst the first studies to analyze the duration until ratification of an IEA, specifically the United Nations Framework Convention on Climate Change (FCCC). They find that the conditional probability of ratification is positively related to total CO_2 emissions and the presence of civil liberties. Neumayer (2002) focuses on the impact of trade openness on ratification delay for the Montreal Protocol, the Biodiversity Convention and CITES. The results suggest that trade openness decreases ratification delay, but not under all measures of openness. Von Stein (2008) analyzes the duration of ratification of two international climate change treaties: the FCCC and the Kyoto Protocol. He finds that states which are more central in international trade networks have ratified FCCC more quickly. This is also the case for countries where there is higher per capita Greenpeace membership and stronger democracies. For the Kyoto Protocol ratification, in addition to the above stated effects, empirical results suggest that among the Annex I countries, higher emissions are linked to slower ratification of the Protocol. Murdoch et al (2003) analyze treaty participation as a two-stage game where countries first decide whether to participate and then they choose their level of participation. They empirically test their model on the adoption of the Helsinki Protocol, applying a binary probit analysis. They find that imported emissions, environmental assets possessed, and the marginal cost of emission reduction positively affect the ratification decision.

Determinants of MARPOL ratification have not been systematically addressed in the quantitative literature, but have been described qualitatively. Mitchell (1994) uses MARPOL as a case study to explain how regime design for IEAs affects compliance. The author finds that political and economic factors fail to fully explain differences in compliance. These differences are further explained by the differences in the subregime's compliance system, such as equipment standards. Churchill (1976) also discusses some common determinants of pre-MARPOL marine convention adoption.

The quantitative literature on the effects of oil spills on the environment is extensive. To name a few recent and influential works: Grigalunas et al. (1986) estimate the economic costs from the Amoco Cadiz oil spill; Cohen (1995) assesses the natural resource damage from the Exxon Valdez oil spill; Carson et al. (2003) measure the lost passive use from the Exxon Valdez oil spill; Garza-Gil et al. (2006) and Loureiro et al. (2009) estimate the economic and environmental damages from the Prestige oil spill in Spain.

A few studies focus on the effectiveness of MARPOL in decreasing various types of pollution. Knapp and Franses (2009), for example, analyze the effects of various measures of international convention effectiveness on several measures of casualty type, casualty seriousness, and loss of life and pollution. The authors specifically analyze the effects of MARPOL variables on tonnage of oil and chemical pollution: (a) entry into force of legal instruments and amendments, (b) indicators for interim periods between adoption and entry into force, and (c) number of IMO member states which have ratified a legal instrument or protocol. To construct measures of oil and chemical pollution, they make use of three different databases: Lloyd's Register Fairplay (LRF), ITOPF, and the Energy Related Safety Accident Database (ENSAD). The main result suggests that time to entry into force of the phase out of the single-hulled tankers decreased the quantity of accidental oil pollution. In terms of chemical pollution, authors find that entry into force of Annex II negatively affects the quantity of chemical pollution, while the number of countries which have ratified the convention affects it positively.

Peet (1992) provides a descriptive analysis of MARPOL effectiveness with respect to ship-based oil pollution. The author observes that by 1991 some 52% of developing countries have ratified the first two Annexes of the treaty. In contrast, some 85% of developed countries have done so by the same date. This difference is hypothesized to arise from differential capacities of the two country-income groups to fully implement technical requirements required by MARPOL. Author also finds that 31% of OPEC (Organization of the Petroleum Exporting Countries) countries have ratified the treaty by 1991, as opposed to 59% of non-OPEC countries. Furthermore, Peet (1992) reviews available evidence on MARPOL effectiveness in decreasing oil pollution, and argues that although several reports purport to have identified an effect, it is likely to be biased. The bias arises from the observation that the compliance and enforcement of the treaty are particularly hard to achieve. Vessel-originate oil pollution released into international waters is unlikely to be reported since it is not likely to be noticed by anyone. Moreover, once reported, the vessels are seldom brought to justice (in their flag countries). In these rare cases when they are, the penalties tend not to be commensurate with the severity of the crime.

4.4. Data

The data on MARPOL ratification duration come from IMO (2010). The treaty was made available for ratification on June 1st, 1978. Legislative delay is calculated as the span of time between June 1st, 1978 and the date when MARPOL entered into force in a given country and. Some countries have still not ratified MARPOL, so the data are right-censored. This necessitates use of survival models that take into account such censoring issues. As of March 31st, 2011, 150 countries had ratified MARPOL Annexes I and II. For those countries that came into existence after June 1978, I compute the delay time from the date of that country's declared independence, so not all durations commence at the same absolute point in time.

The average MARPOL ratification delay for the countries that have ratified the treaty is 5705 days, meaning that more than 15 years had passed by the time half of the countries ratified. Figure 1 plots non-parametric estimates of the survival distribution, which specifies the probability that the delay time will exceed a certain number of days. Figure 2 plots non-parametric estimates of the hazard function. Hazard rate is defined as a frequency at which countries ratify the MARPOL at any particular point in time, conditional on them not having it ratified until that date. The peak of the hazard function is at 135 countries (around year 2003), after which it is characterized by a decreasing hazard or negative duration dependence. This implies that the longer a country takes to ratify MARPOL, the less likely it is that it will do so in the future. Negative duration dependence also briefly occurs right after the first 45 countries ratified the treaty. Trend is reversed in 1989 and the hazard function is characterized by positive duration dependence until 2003. Interestingly, change in the slope of the hazard function occurs right after two major, and highly publicized, oil spills: Odyssey in Canada in November, 1988 and Exxon Valdez in the US in March 1989. However, descriptive graphs alone cannot fully answer the question of the impacts of oil spills on MARPOL ratification delay. For this, one needs to utilize probabilistic survival models.

Figure 1. Survival function estimates

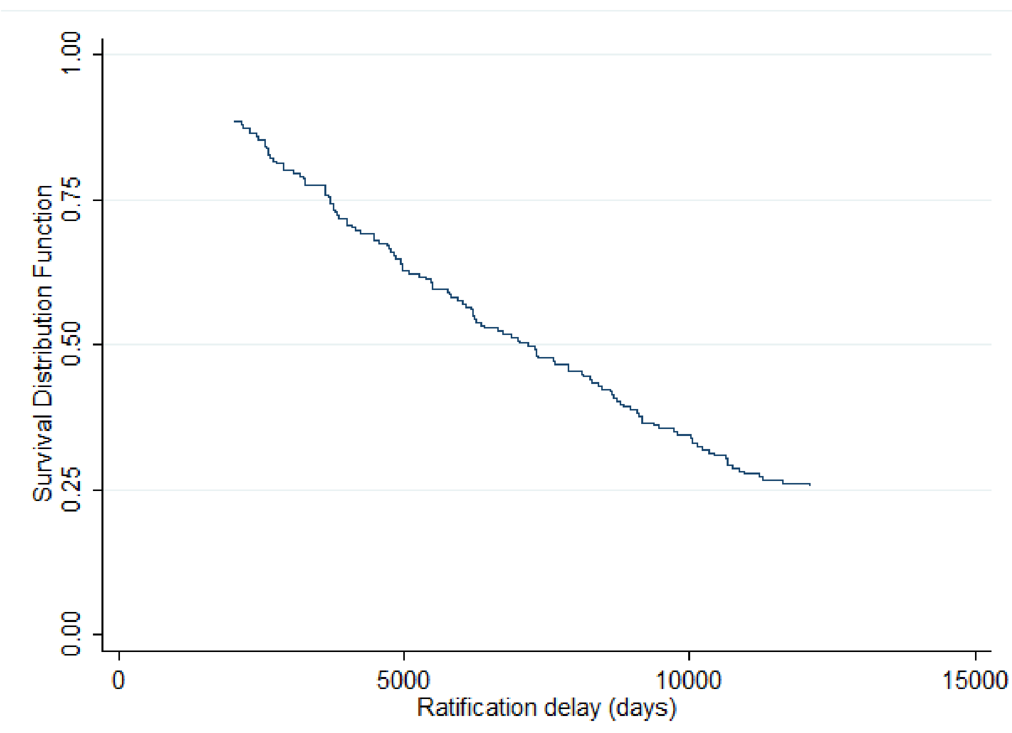
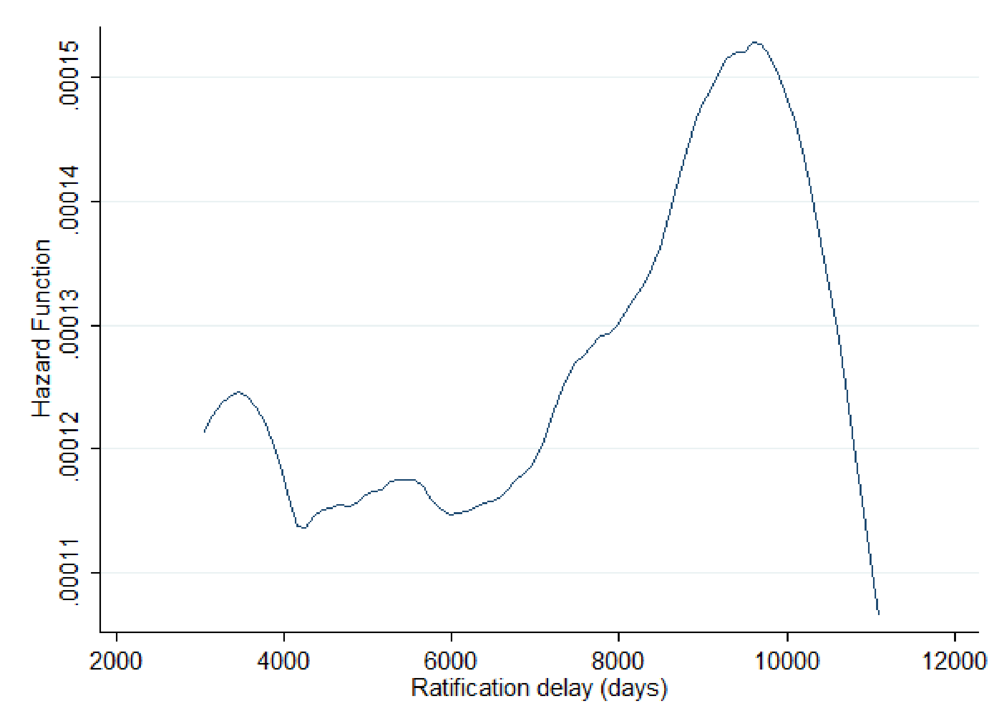


Figure 2. Hazard function estimates



The data on accidental oil spill incidence and quantity of oil spilled are collected from ITOPF[39]. ITOPF manages a database of oil spills originating from seaborne vessels. Data is collected from published sources (the shipping press and other specialist publications), vessel owners and vessel insurers. Since 1970, the first year for which data were gathered, some 5.7 million tons of oil have been accidentally spilled into world oceans and seas in some 2539 detected incidents. The quantity of oil spilled has been decreasing over time (Figure 3) and the number of oil spill incidents has been generally decreasing since about 1980 (Figure 4). This dataset only identifies the locations of the spills and does not contain any information on vessels involved in the spills. So, no information on the flag states is available[40].

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[39] ITOPF data on oil spills has been kindly provided by Susannah Musk of ITOPF. The observation level is country-year.

[40] The flag state of a vessel is the state under whose laws the vessel is registered or licensed.

Figure 3. Annual quantity of oil spilled (in tons)

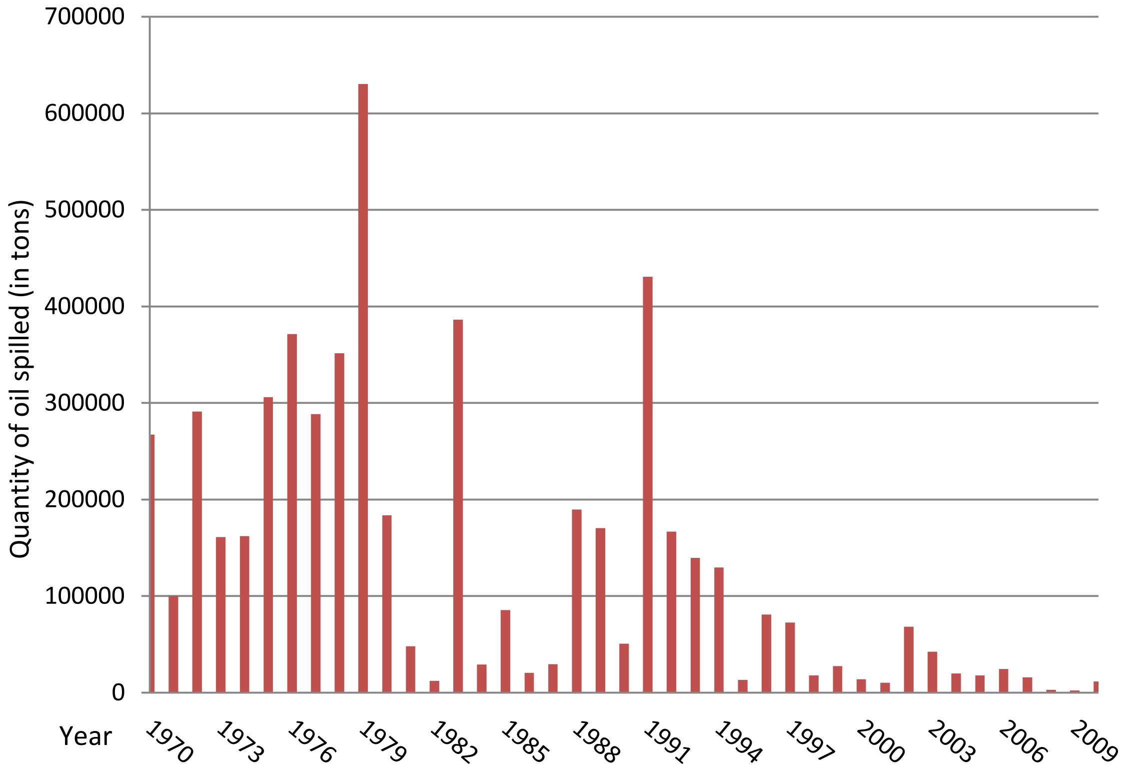
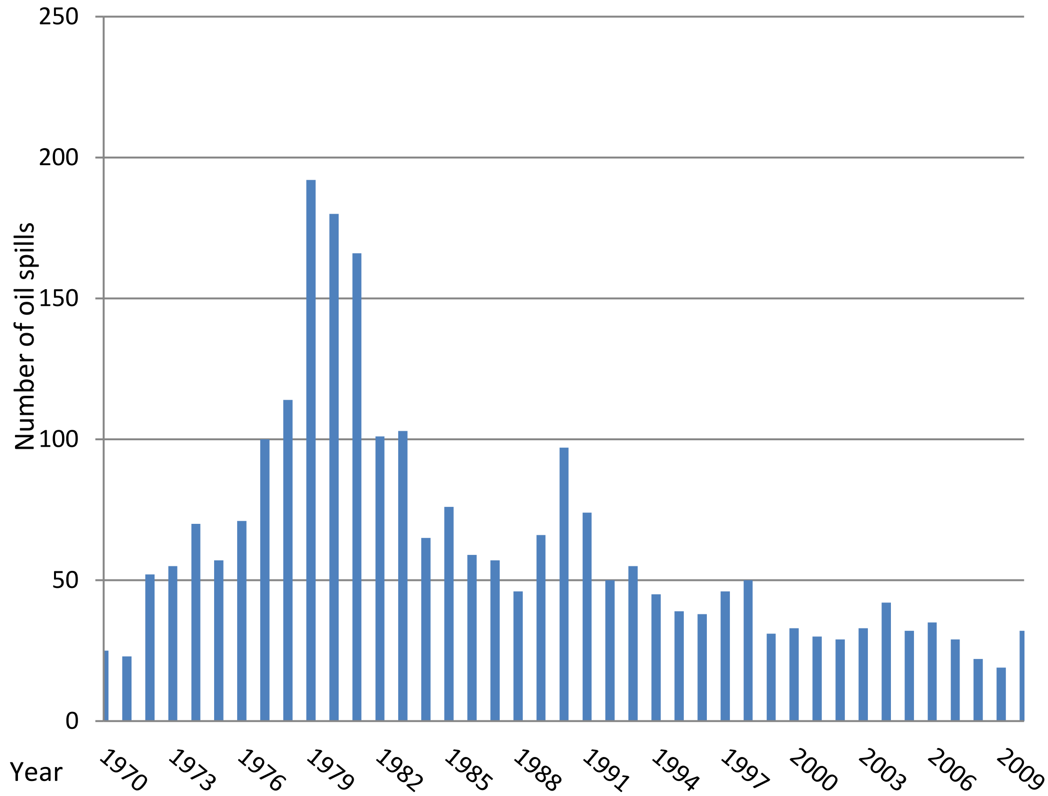


Figure 4. Annual incidence of oil spills



In addition to oil spills, I link the ratification delay data to additional country characteristics. Using the International Environmental Agreements Database Project data (IEADP, 2002), provided by Professor Ronald Mitchell, I construct a variable for the average amount of time it takes for a country to ratify other IEAs. This variable is a proxy for constitutional delays associated with ratifying treaties in general. I also construct a variable measuring the number of non-MARPOL IEAs each country had previously ratified in order to capture each country's propensity for international cooperation on trans-boundary environmental issues. From the World Bank's World Development indicators, I collected data on country land area (in square kilometers) and population. Land area is a proxy for the country's resource base. I obtained data on real GDP (constant 1990 dollars) from the United Nations Statistical Division National Accounts database. Richer countries are likely to have greater demand from their populace for cleaner environment. Data on length of coastline is gathered from the CIA World Factbook. Landlocked countries are not directly impacted by marine pollution, and are thus less likely to participate in a treaty preventing it. Data on trade openness, measured as total trade (exports plus imports) as a percentage of GDP in constant 2005 dollars prices, is collected from Penn World Tables. Governments may ratify an IEA for fear of exclusion from future trade agreements. Also, since much trade is facilitated by the maritime transportation industry, countries that experience large numbers of ships entering their territorial waters are more likely to be attuned to any potential environmental damages from such activities. Consequently, countries with greater trade links have more to lose by not ratifying an IEA. I use the absolute value of the latitude of the capital city, divided by 90, as another measure of economic development (La Porta et al, 1999). Polity score measures level of democratization, where a score of-10 indicates the most oppressive regime and 10 the most democratic one (Marshall & Jaggers, 2002). Democratic societies may be more open to international cooperation and may have greater institutional stability, making them more likely to successfully implement treaties.

Oil production statistics are obtained from the US Energy Information Administration. Oil producing countries may be more likely ratify MARPOL, since they are more exposed to potential spills (if operating oil handling ports). Finally, I collect data on the number of oil tankers operated by a country from the United Nations Conference on Trade and Development (UNCTAD). For MARPOL to enter into force, it needed to be ratified by fifteen countries that constitute at least 50 percent of the world's merchant fleet. This is why the survival curve does not start at time zero.

4.5. Econometric Specification

I employ econometric survival models to analyze the determinants of MARPOL legislative delay. Ordinary Least Squares (OLS) cannot be applied to duration data, since the errors are unlikely to be normally distributed, due to censoring. Thus, OLS estimates are likely to be biased. I explore a variety of duration models, including: semiparametric Cox proportional hazards model, Exponential, Weibull, Gompertz, LogNormal, Loglogistic, a discrete time proportional hazards model (Prentice-Gloeckler, 1978) and logistic regression models. The Cox proportional hazards model is the most flexible survival model, since the hazard function is not specified. The exponential duration distribution has a constant hazard rate, which is often considered too restrictive an assumption. Weibull and Gompertz models have flexible explicit hazard function that can monotonically increase or decrease (Cameron & Trivedi, 2005). In these models, a variable with a positive coefficient estimate is interpreted to have a positive effect on the hazard, implying that this variable is associated with a shorter delay in ratification of MARPOL. For Lognormal model, the natural logarithm of time follows a normal distribution, while for the Loglogistic model, the natural logarithm of time follows a logistic distribution. These two models are estimated using the accelerated failure time model, where the natural logarithm of the survival time, log t, is expressed as a linear function of the covariates. Consequently, the signs on the reported coefficients for both the Lognormal and the Loglogistic model are the opposite of the sign on the coefficients on variables in all other survival models I employ in this analysis. The Prentice-Gloeckler "grouped duration data" proportional hazards regression model isles commonly employed, but is especially appropriate when the timing of the event of interest is not observed exactly but is only known to occur within some specified time interval.

I approach modeling the determinants of MARPOL ratification delay from two perspectives. First I measure ratification delay in continuous time, as the number of days it takes a government to ratify MARPOL. Then I measure delay in discrete time, as the integer number of years it takes a country to ratify it. In the first case all the covariates have values that don't vary with time. Variables characterize the circumstances of the country at the start of the data in 1978 or at the year of independence for all newly (post-1978) formed countries . In the second case, majority of covariates vary with time. There are advantages and disadvantages to each approach. In the continuous case, endogeneity is not an issue, but the number of observations is low. In the discrete case, time varying covariates are more easily implemented. Allowing for temporal variation in covariates allows me to analyze the impact of changing conditions, such as occurrence of new oil spills, on ratification delay. Endogeneity may be an issue, but unfortunately it cannot yet be easily addressed in a duration model framework. In addition to the usual difficulty of finding proper instruments, there are no available survival models that can easily implement endogeneity.[41]

As discussed in the data section, the proposed determinants of MARPOL legislative delay are: population in 100,000s of people, PolityIV score for level of democratization, trade openness, GDP in billions of 1990$, oil production in thousands of barrels, oil tanker fleet capacity in 100,000s of tons, average time to ratify IEA in days, total number of prior IEAs ratified, land area in thousands of square kilometers, coastline length in 100s of kilometers and absolute latitude. When modeling delay as a continuous variable, covariates values are measured only at the start of the event whose duration is measured. In this case it is year 1978 when MARPOL became available for ratification, except for new countries where date of independence is used in the calculation. The summary statistics for these covariates are available in Table 2. In the discrete case, all covariates, other than average time to ratify IEA in days, total number of IEAs ratified, land area, coastline length and latitude, are time-varying (Table 3).

I use two measures of oil spills, the number of incidents and the quantity spilled in tons. Specific to the continuous-time delay models, I create variables measuring total quantity and total incidents of oil spillages in tanker accidents between 1970 and 1978 for each country. Since these events occur prior to MARPOL they are exogenous to (or at

[41] Even in the case of a single endogenous regressor, it would be necessary to work with the joint distribution of two dependent variables. Perhaps the framework of a lognormal duration model could be adopted to a bivariate normal error distribution to accommodate a normally distributed endogenous regressor.

least pre-determined, relative to) legislative delay. In the discrete case, I generate time-varying variables for number of incidents and quantities spilled for each country. These variables start in 1978, with advent of MARPOL, and continue until a country ratifies the treaty. If a country doesn't ratify MARPOL then values for spill incidence and quantity start in 1978 and continue until 2009. The unit of observation in these models is country-year. In both cases I start by estimating a model of the impact of quantity of oil spilled on country's MARPOL ratification delay. I include all proposed covariates, other than the number of incidents of oil spills. I then explore a specification where I include a measure of the number of oil spill incidents, but exclude amount spilled. Finally, I estimate a model where I include both the number of incidents and the amount spilled. In the continuous and discrete cases of the specifications I also include a quadratic term in the measures of oil spills to control for non-linearity. The number of incidents and the amount-spilled variables allow me to test the hypothesis that environmental disasters act as catalysts in a country's decision to ratify MARPOL.

Table 2. Summary statistics for models without time-varying covariates

Variable	Mean	Std. Dev.	Min	Max
Pre 1978 oil spill quantity (tons)	7253.452	27958.16	0	296871
Pre 1978 oil spill incidents	1.645833	6.645046	0	73
Population (in 100,000s)	250.099	931.6277	0.24428	9561.65
PolityIV	-2.13971	7.413874	-10	10
Trade openness	70.58915	46.73913	8.783233	324.5395
GDP (in billions of 1990$)	94.66281	383.1778	0.009396	4065.46
Oil production (thousands of barrels)	2.661129	11.12752	0	102.74
Oil tankers (100,000s of tons)	17.56985	87.36815	0	1049.211
Average time to ratify IEA (days)	3537.473	1185.579	261	7220.429
Total number of IEAs ratified	20.73143	15.7645	1	83
Land area (thousands of sq.km)	781.8773	2053.362	0.002	17098.24
Coastline length (100s of km)	40.90087	164.2889	0	2020.8
Latitude	0.257365	0.180323	0	0.722222

Table 3. Summary statistics for models with time-varying covariates

Variable	Mean	Std. Dev.	Min	Max
Oil spill quantity (tons)	604.7078	9348.273	0	301001
Oil spill incidents	0.254626	2.118015	0	75
Population (in 100,000s)	179.1644	607.3719	0.24428	10233.1
PolityIV	-0.88632	7.02027	-10	10
Trade openness	78.31955	48.09096	1.086023	398.9536
GDP (in billions of 1990$)	43.77506	227.6552	0.006632	4395.47
Oil production (thousands of barrels)	2.26773	9.436066	0	111.1443
Oil tankers (100,000s of tons)	6.579656	46.67458	0	1049.211
Average time to ratify IEA (days)	3649.547	1159.229	261	7220.429
Total number of IEAs ratified	16.37949	11.43079	1	83
Land area (thousands of sq.km)	587.5135	1430.564	0.002	17098.24
Coastline length (100s of km)	27.97714	140.8444	0	2020.8
Latitude	0.233324	0.159493	0	0.722222

4.6. Empirical Results

4.6.1. *Continuous Models without Time-Varying Covariates*

I estimate three types of specifications: (a) the total quantity of oil spilled, (b) the number of spill incidents, and (c) the combined model, each using six different assumptions about the hazard function. Specifically, I employ Exponential, Weibull, Gompertz, lognormal, loglogistic ande semiparametric Cox proportional hazards model.[42] LogNormal and Loglogistic specifications are reported in accelerated failure time (AFT) formats. After calculating the maximum log likelihoods, Akaike information criterion (AIC), and Bayesian information criterion, for each specification, I found that the Weibull specification is the most appropriate one (Tables 4, A1, A2 and A3). For the dependent variable, I use the MARPOL Annex I ratification delay measured in days. The

[42] Prentice-Gloeckler discrete time proportional hazards model can only be used in models with time varying covariates.

amount spilled variable is a sum of all the prior oil spills in a given country between 1970 and 1978, while the number of oil spill incidents variable is the frequency of spills over the same prior time period.

4.6.1.1. Models Employing the Amount of Oil Spilled Prior to 1978

The coefficient on amount spilled is significant at 1% level, having a positive impact on the hazard, implying that, holding all else constant, an increase in the prior amount of oil spilled decreases the number of days it takes a given country to ratify MARPOL (Table 4).[43] The square of the prior amount of oil spilled is significant as well pointing to non-linearities in the effect of oil spills on ratification delay. It has a negative impact on the hazard, suggesting eventual diminishing in the effect of the amount of oil spilled. These results add credence to the hypothesis that increased experience of environmental disasters leads to greater demand for policies mitigating their impacts. Other covariates found to have a consistent impact on legislative delay across specifications are: population size, trade openness, tanker fleet size and total number of IEAs ratified (Table 4). Results suggest that countries with larger populations will take less time to ratify MARPOL. This confirms the hypothesis that the greater the number of people affected, the greater the demand for a policy response. Trade openness is also found to be positively related to the hazard, suggesting that countries more open to trade have more to lose from not ratifying an IEA, in terms of potential future cooperation, and are thus likely to take less time to ratify MARPOL. Countries with larger tanker fleets are

[43] This is the case in all six specifications (Table A1, A2 and A3)

also more likely to take less time to ratify MARPOL. This result largely captures the requirement for MARPOL to enter into force of at least 15 countries joining with combined merchant fleet of no less than 50 percent of the gross tonnage of the world's commercial shipping. Countries that have ratified a greater number of prior non-MARPOL IEAs are also likely to take less time to ratify MARPOL.

4.6.1.2. Models Employing the Number of Oil Spills Prior to 1978

The impact of the number of prior oil spills during 1970-78 is found to be statistically significant, and positive, in Weibull specification (Table 4).[44] There appears to be no firm evidence of non-linear impacts of the prior frequency of oil spills on ratification delay. Correlation between the number of oil spills and the quantity of oil spilled prior to 1978 is 0.69. Again, I find that population size, trade openness, tanker fleet size and total number of prior IEAs ratified, each have the same impact on the hazard of ratification.

4.6.1.3. Models Employing both the Spill Quantities and the Number of Spills Prior to 1978

When I include both the total amount of prior oil spilled and the number of prior oil spills (1970-1978) as covariates in a regression, the estimated results are not qualitatively different from those in models where the two variables enter separately (Table 4). In other words, the amount spilled is found to decrease time to ratify, and the

[44] It is also only significant in the Cox specification.

impact is non-linear. The number of oil spill incidents is found to have no robustly significant effect on ratification delay. Population size, trade openness, tanker fleet size and total number of prior IEAs ratified, have similar impacts on the hazard of ratification.[45]

Table 4. Determinants of MARPOL legislative delay - Weibull specifications for oil spills between 1970 and 1978 (period 1978-2009, n=129)

	I	II	III
Pre 1978 oil spill quantity (in 10,000s of tons)	0.2607***	--	0.3481***
	(0.0885)		(0.1001)
Square of pre 1978 oil spill quantity (in 10,000s of tons)	-0.0086*	--	-0.0154**
	(0.0047)		(0.0075)
Pre 1978 oil spill incidents (in tens)	--	0.6068*	0.1949
		(0.3452)	(0.6372)
Square of pre 1978 oil spill incidents (in tens)	--	-0.0439	0.1158
		(0.0765)	(0.1767)
Population (in millions)	0.0028***	0.0032***	0.0026***
	(0.0010)	(0.0011)	(0.0009)
PolityIV	0.0283	0.0300	0.0266
	(0.0205)	(0.0207)	(0.0209)
Trade openness	0.0082***	0.0068***	0.0082***
	(0.0019)	(0.0019)	(0.0020)
GDP (in hundreds of billions of 1990$)	0.0200	-0.0294	-0.0834
	(0.0652)	(0.0681)	(0.0601)
Oil production (thousands of barrels)	-0.0012	-0.0300	-0.0083
	(0.0555)	(0.0588)	(0.0653)
Oil tankers (100,000s of tons)	0.0041***	0.0040***	0.0042***
	(0.0004)	(0.0004)	(0.0004)
Average time to ratify previous IEAs (days/365)	0.0548	0.0506	0.0584
	(0.0396)	(0.0389)	(0.0406)
Total number of previous IEAs ratified	0.0687***	0.0689***	0.0749***
	(0.0135)	(0.0138)	(0.0162)
Land area (100,000s of sq.km)	0.0084	0.0093	0.0116
	(0.0120)	(0.0135)	(0.0115)
Coastline length (thousands of km)	-0.0051	-0.0021	-0.0067
	(0.0073)	(0.0077)	(0.0072)
Latitude	-0.8934	-1.1128	-1.2225
	(1.0546)	(1.0068)	(1.0866)
Constant	-25.2662***	-24.4638***	-25.8383***
	(2.0214)	(1.9721)	(2.1294)
Shape parameter	0.925***	0.8996***	0.9448***
Log-likelihood	-95.1	-98.76	-93.1
AIC	220.1	227.53	220.3
BIC	263.0	270.42	268.9

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

[45] I have also explored specifications that include an interaction term between the number of oil spills and the amount spilled pre-1978. The coefficient on the interaction suggests no effect on the hazard of ratifying MARPOL.

4.6.2. *Continuous Models with Time-varying Covariates*

I estimate eight different specifications involving different assumptions about the hazard function, each for models that employ the total amount of concurrent spills, the number of concurrent spill incidents and the combined model,. Specifically, I employ Exponential, Weibull, Gompertz, lognormal and loglogistic models, adiscrete time proportional hazards model (Prentice-Gloeckler, 1978), a semiparametric Cox proportional hazards model and a Logit model. Lognormal and loglogistic specifications are estimated as accelerated failure time specification. Again, I found that the Weibull specification is the most appropriate one (Tables 5, B1, B2 and B3). For the dependent variable I use the MARPOL Annex I ratification delay measured in integer years. The amount spilled covariate now measures the total quantity of oil spilled during each year between 1978 and the year in which the country in question ratified the treaty. The number of oil spill incidents variable is now the annual frequency of spills over the same time period.[46] Unlike the case in the last section, most covariates are now time-varying. It is important to note that both of the oil spill variables are likely to be endogenous. Specifically, oil spills are likely to be impacted by passage of MARPOL (Knapp and Franses (2009). It is non-trivial to correct for endogeneity in a survival model framework, as there are no appropriate stylized models currently available. So the following models assume oil spills covariates are exogenous. [47]

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[46] I have estimated specifications where I also included oil spill incidents and total amount of oil spilled prior to 1978, and the results do not substantively differ from those in the models without these variables.

[47] I have attempted to use standard regression techniques to address the endogeneity issue. Specifically, I have identified oil prices as a suitable instrument that affects the number of oil spill incidents and the quantity spilled. Higher oil prices put pressures on distribution networks to supply more oil. Tankers are

4.6.2.1. Models Employing the Concurrent Amount of Oil Spilled

I found the coefficient on amount of oil spilled, as well as its squared term, to be significant at 5% level (Table 5). Other covariates with coefficients significant across specifications are population, trade openness, total number of IEAs and tanker fleet capacity. In some specifications, average time to ratify prior IEAs is found to have a positive impact on the hazard (Tables B1, B2 and B3). A similar result is found with oil production covariate, implying which countries that are oil producers are likely to take less time to ratify MARPOL. Such countries are more likely to be affected by spills in their own waters, due to frequent handling of the good. PolityIV score is also significant in four specifications, suggesting that more democratic countries take less time to ratify MARPOL (Tables B1, B2 and B3).

4.6.2.2. Models Employing Concurrent Number of Oil Spills

Neither the number of oil spill incidents nor the squared term of this variable are found to have any effect on a country's MARPOL ratification delay (Table 5). All other covariates have similar impacts as in the specifications using the amount of oil spilled.

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more likely to travel faster and take more risks in inclement weather to deliver the oil under higher prices. This has been identified as an important determinant in the oil spills literature. It also unlikely that oil price would affect MARPOL ratification delay. However, I found no effect for oil spill covariates when using 2SLS estimator. This is likely to be the case because 2SLS does not properly handle censoring.

4.6.2.3. Models Employing both Concurrent Spill Quantities and Number of Spills

In the final model, with both types of concurrent oil spills covariates included (and their respective square terms), I find evidence of an impact of the amount of oil spilled (and its squared term) on MARPOL ratification delay (Table 5). Again, the results suggest that an increase in the amount of oil spilled in any given year shortens the amount of time (or increases the hazard rate for ratifying MARPOL) necessary to ratify MARPOL. The number of oil spill incidents is found to be significant in three out of eight models, with impact in these cases being negative on the hazard of ratifying MARPOL. Correlation between the number of oil spills and the quantity of oil spilled variables is 0.13. All other covariates have similar impact as in sections (i) and (ii).[48]

4.7. Conclusion

In this study, I focus on the impact of relevant environmental pollution events, specifically oil spills originating from ocean-going vessels, on ratification delay for a major marine pollution international environmental agreement (IEA) known as MARPOL Annex I. These findings suggest that a greater quantity of oil spilled in countries' marine environments corresponds to a shorter time to ratify MARPOL. These results contribute to the existing literature on IEAs by providing some of the first evidence that unexpected environmental disasters act as catalysts for the adoption of international environmental policies. This is the first study to analyze MARPOL ratification delay in a quantitative fashion. I find that a country's population size, trade

[48] I have also explored specifications that include an interaction term between the number of oil spills and the amount spilled. The coefficient on the interaction seems to have a significant, and positive, effect on the hazard of ratifying MARPOL.

openness, tanker fleet size and number of other IEAs previously ratified, are all negatively related to the duration of country's MARPOL ratification delay. In the future I plan to expand this approach to model ratification delays for other IEAs to see whether other types of environmental disasters relevant to those IEAs have a similar effect.

Table 5. Determinants of MARPOL legislative delay - Weibull specifications for concurrent oil spills (1978-2009, n=2499)

	I	II	III
Oil spill quantity (in 10,000s of tons)	4.5994**	--	5.4206**
	(2.1131)		(2.3846)
Square of oil spill quantity (in 10,000s of tons)	-4.77228*	--	-5.2840**
	(2.43720)		(2.5332)
Oil spill incidents (in tens)	--	-0.0790	-0.7690
		(0.5627)	(0.8729)
Square of oil spill incidence (in tens)	--	-0.0467	0.0005
		(0.1513)	(0.0020)
Population (in millions)	0.0034***	0.0035***	0.0032***
	(0.0011)	(0.0011)	(0.0010)
PolityIV	0.0134	0.0169	0.0162
	(0.0183)	(0.0186)	(0.0184)
Trade openness	0.0066***	0.0066***	0.0066***
	(0.0019)	(0.0020)	(0.0019)
GDP (in hundreds of billions of 1990$)	-0.0010	0.0298	0.0364
	(0.0307)	(0.0544)	(0.0476)
Oil production (thousands of barrels)	0.0559	0.0830	0.0678
	(0.0534)	(0.0557)	(0.0508)
Oil tankers (100,000s of tons)	0.0051***	0.0051***	0.0051***
	(0.0006)	(0.0006)	(0.0005)
Average time to ratify previous IEAs (days/365)	0.0626	0.0634	0.0640
	(0.0409)	(0.0407)	(0.0406)
Total number of previous IEAs ratified	0.0880***	0.0829***	0.0849***
	(0.0123)	(0.0126)	(0.0120)
Land area (100,000s of sq.km)	0.0032	0.0043	0.0038
	(0.0134)	(0.0140)	(0.0126)
Coastline length (thousands of km)	0.0013	-0.0008	0.0006
	(0.0063)	(0.0070)	(0.0064)
Latitude	-0.9963	-0.7573	-0.8715
	(1.0108)	(1.0204)	(0.9924)
Constant	-11.7905***	-11.6709***	-11.6450***
	(0.9989)	(1.0076)	(0.9912)
Shape parameter	1.0397***	1.0291***	1.0240***
Log-likelihood	-81.7	-84.1	-81.3
AIC	193.4	198.3	196.5
BIC	280.7	285.6	295.5

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Possible extensions include nuclear safety treaties and the impact of worldwide nuclear accidents on their ratification delay. A second planned application concerns hazardous substances treaties and related accidents.

CHAPTER V

CONCLUSION

This dissertation consists of three essays focusing on voluntary approaches to environmental policy and political economy of environmental disasters. In Chapter II analyze the effects of eco-labeling in service industries, expanding the scope of the existing literature focusing primarily on goods industries. The study concerns eco-labeling in the tourism industry, specifically the impact of the Blue Flag label for marinas and beaches on prices of marina slip rental prices, weekly sailboat charter prices and hotel accommodation prices. The principal findings include that Blue Flag certified marinas appear to enjoy an average premium between 6.6% and 22% for their daily slip rental prices; between 40% and 49% for their monthly slip rental prices; and 23% for their yearly slip rental prices. Within the sailboat charter sector, vessels whose home marina is awarded the Blue Flag on average carry a price premium between 14% and 20% on a weekly sailboat rental. When it comes to hotel accommodation, hotels managing a Blue Flag certified beach enjoy a price premium between 45% and 270%. In the future I plan on expanding my research on eco-labeling by focusing on the impact of Blue Flag on water quality. I also plan on exploring the impact of sustainable forestry labels on the exit of wood mills from the wood product market.

In Chapter III I examine the effect of climate change on violent conflict. The contribution lays in the application of climate change measures that are new to the civil wars literature. I employ a dataset on global frequency of climate-change related natural disasters to explain the probability of the start and occurrence, in a given year, of civil war, and duration, during the last half of the 20th century. The results point to a conclusion that societies might avoid some of the expected, and otherwise often negative, effects of natural disasters related to climate change. Extreme cold events and epidemic outbreaks are found to have a measurable positive effect on the probability of civil war starting in the affected countries; previous years extreme heat events are found to have a positive effect on the probability of a civil war occurring in a given year; and droughts are found to have a positive effect on civil war duration. These findings may be used by policy makers as they contemplate climate change adaptation and mitigation policies. In the future I plan on focusing on the impacts of climate-change-related disasters on various measures of civil strife on subnational levels.

In the fourth chapter I examine the impact of unexpected pollution events on the adoption of a major marine pollution IEA, MARPOL. Specifically, I focus on the impacts of oil spills originating from ocean-going vessels on the ratification delay of MARPOL Annex I. My findings suggest that a greater quantity of oil spilled in countries' marine environments corresponds to a shorter time to ratify MARPOL. The results contribute to the existing literature on IEAs by providing some of the first evidence that unexpected environmental disasters act as catalysts for the adoption of international environmental policies. In the future I plan to expand this approach to model ratification delays for other IEAs to see whether other types of environmental disasters relevant to those IEAs have a similar effect.

APPENDIX 1

SUPPLEMENTARY INFORMATION FOR CHAPTER II

A. Hotel Sampling Information And First Stage Estimates For Simultaneous Equations Specifications

Table A1. Hotel population and sample counts with and without Blue Flag beach certification (by county and stars)

		Population		Sample	
County	Stars	All	With Blue Flag	All	With Blue Flag
Dubrovacko-neretvanska	2	12	0	3	0
	3	39	2	9	0
	4	8	1	1	0
	5	8	1	4	1
Istarska	2	14	2	3	0
	3	51	14	12	4
	4	19	6	4	1
	5	1	1	0	0
Licko-Senjska	2	5	0	2	0
	3	6	0	2	0
	4	2	0	1	0
	5	0	0	0	0
Primorsko-goranska	2	21	2	4	1
	3	50	1	9	0
	4	27	1	4	0
	5	3	0	1	0
Splitsko-dalmatinska	2	23	0	4	0
	3	61	0	11	0
	4	27	1	9	1
	5	2	1	1	0
Sibensko-kninska	2	4	0	1	0
	3	16	1	3	0
	4	6	4	1	1
	5	0	0	0	0
Zadarska	2	4	0	1	0
	3	20	2	4	0
	4	11	1	3	0
	5	0	0	0	0
All Counties	98	440	41	97	9

Table A2. Determinants of Marina Blue Flag Certification Status Using Daily Slip-rental Data (n=9369)

Variables	(1) 2SLS	(2) RE 2SLS
1(ACI Marina)	5.77***	5.78***
	(0.062)	(0.062)
1(Second category marina)	-0.162***	-0.157***
	(0.0070)	(0.0070)
1(Third category marina)	-0.579***	-0.577***
	(0.0077)	(0.0078)
1(Uncategorized marina)	-0.665***	-0.659***
	(0.015)	(0.015)
log(Slips) (number of available spots)	0.293***	0.292***
	(0.0066)	(0.0066)
Dry dock (number of available spots)	-0.000267***	-0.000255***
	(0.000045)	(0.000046)
1(Travel lift)	-0.261***	-0.263***
	(0.0093)	(0.0093)
1(Grocery store)	0.136****	0.145***
	(0.011)	(0.0073)
1(Restaurant)	-0.389***	-0.393***
	(0.016)	(0.016)
1(Laundry facilities)	0.142***	0.138***
	(0.0072)	(0.011)
log(Airport distance, km)	-0.0559***	-0.0555***
	(0.0043)	(0.0043)
Marine fuel station distance (km)	-0.00957***	-0.00948***
	(0.00067)	(0.00067)
1(Island location)	0.289***	0.290***
	(0.0078)	(0.0078)
Population (of the associated urban area, in thousands)	-0.000595***	-0.000596***
	(0.000075)	(0.000076)
1(Urban location)	-0.202***	-0.201***
	(0.011)	(0.010)
log(Average county monthly tourist arrivals, in thousands)	-0.0092***	-0.0000790
	(0.0013)	(0.00012)
1(Crane)	-0.102***	-0.104***
	(0.0085)	(0.0085)
1(Parking)	0.181***	0.181***
	(0.014)	(0.014)
1(Slipway)	-0.140***	-0.141***
	(0.0047)	(0.0047)
CountyBFMarinas	0.0764***	0.0810***
	(0.0027)	(0.0026)
FirmBFMarinas	-0.783***	-0.784***
	(0.0080)	(0.0080)
Constant	-0.376***	-0.489***
	(0.044)	(0.042)
R^2	0.86	

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, *p<0.1. Columns (1) and (2) represent estimates of the first stage specification from equation (2) on pp.13. for daily-slip-rentals, obtained by using 2SLS and RE 2SLS methods, respectively.

Table A3. Determinants of Marina Blue Flag Certification Status Using Monthly Slip-rental Data (n=5315)

Variables	(1) 2SLS	(2) RE 2SLS
1(ACI Marina)	6.14***	6.15***
	(0.058)	(0.058)
1(Second category marina)	-0.432***	-0.432***
	(0.0063)	(0.0063)
1(Third category marina)	-0.491***	-0.491***
	(0.0083)	(0.0083)
1(Uncategorized marina)	--	--
	--	--
log(Slips) (number of available spots)	-0.0331***	-0.0350***
	(0.011)	(0.011)
Dry dock (number of available spots)	0.00284***	0.00286***
	(0.000092)	(0.000091)
1(Travel lift)	-0.145***	-0.145***
	(0.012)	(0.012)
1(Grocery store)	0.199***	0.199***
	(0.0085)	(0.0086)
1(Restaurant)	-0.0508***	-0.0523***
	(0.017)	(0.017)
1(Laundry facilities)	-0.0303***	-0.0305***
	(0.0076)	(0.0076)
log(Airport distance, km)	-0.0464***	-0.0459***
	(0.0042)	(0.0041)
Marine fuel station distance (km)	-0.0131***	-0.0129***
	(0.0011)	(0.0011)
1(Island location)	0.368***	0.366***
	(0.010)	(0.010)
Population (of the associated urban area, in thousands)	0.00158***	0.00159***
	(0.000068)	(0.000068)
1(Urban location)	0.379***	0.381***
	(0.016)	(0.014)
log(Average county monthly tourist arrivals, thousands)	-0.00170	-0.00000781
	(0.0011)	(0.000077)
1(Crane)	0.0333***	0.0339***
	(0.0094)	(0.0094106)
1(Parking)	--	--
	--	--
1(Slipway)	-0.232***	-0.232***
	(0.0041)	(0.0041)
CountyBFMarinas	0.097***	0.097***
	(0.0028)	(0.0027)
FirmBFMarinas	-0.805***	-0.806***
	(0.0073)	(0.0073)
Constant	0.211***	0.195***
	(0.056)	(0.055)
R^2	0.94	

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, *p<0.1. Columns (1) and (2) are estimates of the first stage specification from equation (2) on pp.13. for monthly slip-rentals, obtained by using 2SLS and RE 2SLS methods, respectively.

Table A4. Determinants of Marina Blue Flag Certification Status Using Yearly Slip-rental Data (n=616)

Variables	(1) 2SLS
1(ACI Marina)	5.47***
	(0.23)
1(Second category marina)	-0.287***
	(0.029)
1(Third category marina)	-0.637***
	(0.029)
1(Uncategorized marina)	-0.842***
	(0.081)
log(Slips) (number of available spots)	0.357***
	(0.025)
Dry dock (number of available spots)	-0.000787***
	(0.00018)
1(Travel lift)	-0.288***
	(0.037)
1(Grocery store)	0.136***
	(0.0409***)
1(Restaurant)	--
	--
1(Laundry facilities)	0.100***
	(0.027)
log(Airport distance, km)	-0.102***
	(0.016)
Marine fuel station distance (km)	-0.0114***
	(0.0024)
1(Island location)	0.413***
	(0.032)
Population (of the associated urban area, in thousands)	-0.000476*
	(0.00028)
1(Urban location)	-0.416***
	(0.051)
log(Average county monthly tourist arrivals, in thousands)	-0.189***
	(0.023)
1(Crane)	-0.128***
	(0.036)
1(Parking)	--
	--
1(Slipway)	-0.119***
	(0.018)
CountyBFMarinas	-0.0431**
	(0.020)
FirmBFMarinas	-0.748***
	(0.029)
Constant	1.55***
	(0.299477)
R^2	0.86

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, *p<0.1. Column (1) represents estimates of the first stage specification from equation (2) on pp.13. for yearly slip-rentals, obtained by using 2SLS method.

Table A5. Determinants of Home Marina Blue Flag Certification Status (n=16651)

Variables	(1) 2SLS	(2) RE 2SLS
log (Marina yearly slip rental price)	1.47***	1.45***
	(0.019)	(0.019)
log(Ship length) (meters)	-1.62***	-1.65***
	(0.033)	(0.034)
Number of beds	0.0152***	0.0147***
	(0.0022)	(0.0023)
Vessel age (years)	0.0106***	0.0114***
	(0.0011)	(0.0011)
Vessel age^2 (years)/10^5	-0.539***	-0.57***
	(0.055)	(0.054)
Vessel weight (tons) /10^2	0.585***	0.621***
	(0.060)	(0.061)
Fuel capacity (tons)	-0.330***	-0.266***
	(0.043)	(0.044)
1(Nautical charts and guides)	0.131***	0.133***
	(0.0096)	(0.0098)
1(Global positioning system)	0.351***	0.358***
	(0.0094)	(0.0095)
1(Marine VHF radio)	0.523***	0.536***
	(0.014)	(0.014)
1(Electric refrigerator)	-0.0409***	-0.0451***
	(0.0070)	(0.0070)
Gas cooker with oven (1 if available, 0 otherwise)	-0.0815***	-0.0793***
	(0.0068)	(0.0069)
1 (Electric anchor available)	0.0125	0.0104
	(0.022)	(0.022)
log(Average county monthly tourist arrivals, in thousands)	-0.0124***	-0.000137
	(0.0014)	(0.00015)
CountyBFMarinas	0.0644***	0.0806***
	(0.0031)	(0.0031)
FirmBFMarinas	-0.00485***	-0.005726***
	(0.00082)	(0.00083)
Constant	-8.31***	-8.35***
	(0.13)	(0.13)
R^2	0.55	

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, *p<0.1. Columns (1) and (2) are estimates of the first stage specification from equation (4) on pp.14., obtained by using 2SLS and RE 2SLS methods, respectively.

Table A6. Determinants of Hotel Beach Blue Flag Certification Status (n=969)

Variables	(1) 2SLS	(2) RE 2SLS
log(Airport distance, km)	0.658***	1.02***
	(0.061)	(0.064)
1(3-star hotel)	-0.0376**	-0.0771***
	(0.017)	(0.019)
1(4-star hotel)	0.108***	0.0897***
	(0.022)	(0.025)
1(5-star hotel)	0.118***	0.159***
	(0.028)	(0.031)
log(Number of rooms)	0.0185**	0.0384***
	(0.0085)	(0.0097)
1(Air-conditioning)	-0.0942***	-0.133***
	(0.017)	(0.018)
1(Sports facilities)	0.296***	0.327***
	(0.022)	(0.0242)
1(Island location)	-1.95***	2.88***
	(0.12)	(0.19)
log(Population, in associated urban area, in thousands)	0.102***	0.236***
	(0.022)	(0.017)
log(Average county monthly tourist arrivals, in thousands)	-0.00313	-0.0000247
	(0.0036)	(0.00043)
CountyBFBeaches	0.172***	-0.0539***
	(0.014)	(0.00355)
FirmBFBeaches	-0.128***	-0.124***
	(0.013)	(0.014)
Constant	-4.14***	-5.00***
	(0.47)	(0.33)
R^2	0.77	

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, *p<0.1. Columns (1) and (2) represent estimates of the first stage specification from equation (6) on pp.16., obtained by using 2SLS and RE 2SLS methods, respectively.

B. Blue Flag Marina Criteria

ENVIRONMENTAL EDUCATION AND INFORMATION

- Environmental information about natural sensitive nearby land and marine areas is supplied to marina users (i).
- Code of environmental conduct is posted in the marina (i).
- Information about the Blue Flag Marina Programme and/or the Blue Flag Marina Criteria are posted in the marina (i).
- The marina should be able to demonstrate that at least three environmental education activities are offered to the users and staff of the marina (i)
- The Individual Blue Flag for boat owners is offered through the marina (i).

ENVIRONMENTAL MANAGEMENT

- Production of an environmental policy and plan at the marina. The plan should include references to water, waste and energy consumption, health and safety issues, and the use of environmentally sound products when available (i).
- Adequate and properly identified and segregated containers for the storage of hazardous wastes (paints, solvents, boat scrapings, antifouling agents, batteries, waste oil, flares). The wastes should be handled by a licensed contractor and disposed of at a licensed facility for hazardous waste (i).
- Adequate and well managed litterbins and/or garbage containers. The wastes should be handled by a licensed contractor and disposed of by a licensed facility (i).
- The marina has facilities for receiving recyclable waste materials, such as bottles, cans, paper, plastic, organic material, etc. (i).
- Bilge water pumping facilities are present in the marina (g).
- Toilet pumping facilities are present in the marina (g).
- All buildings and equipment must be properly maintained and in compliance with national legislation. The marina must be in a good integration with the surrounding natural and built environment (i).

- Adequate, clean and well sign-posted sanitary facilities, including washing facilities and drinking water. Controlled sewage disposal to a licensed sewage treatment (i).

- If the marina has boat repairing and washing areas, no pollution must enter the sewage system, marina land and water or the natural surroundings (i).

- Promotion of sustainable transportation (g).

- No parking/driving in the marina, unless in specific designated areas (i).

SAFETY AND SERVICES

- Adequate, clean and well sign-posted lifesaving, first-aid equipment and fire-fighting equipment. Equipment must be approved by national authorities.

- Emergency plan in case of pollution, fire or other accidents must be produced (i).

- Safety precautions and information must be posted at the marina (i).

- Electricity and water is available at the berths, installations must be approved according to national legislation (i).

- Facilities for disabled people (g).

- Map indicating the location of the different facilities is posted at the marina (i).

WATER QUALITY

- Visually clean water (no oil, litter, sewage or other evidence of pollution) (i).

C. Blue Flag Beach Criteria

ENVIRONMENTAL EDUCATION AND INFORMATION

- Information relating to coastal zone ecosystems and natural, sensitive areas in the coastal zone must be displayed
- Information about bathing water quality must be displayed
- Information about the Blue Flag Programme must be displayed
- Code of conduct for the beach area must be displayed and the laws governing beach use must be easily available to the public upon request
- A minimum of 5 environmental education activities must be offered

WATER QUALITY

- Compliance with the requirements and standards for excellent bathing water quality
- No industrial or sewage related discharges may affect the beach area
- Monitoring on the health of coral reefs located in the vicinity of the beach
- Compliance of the community with requirements for sewage treatment and effluent quality
- Algae or other vegetation should be left to decay on the beach unless it constitutes a nuisance

ENVIRONMENTAL MANAGEMENT

- A beach management committee must be established to be in charge of instituting environmental management systems and conduct regular environmental audits of the beach facility
- The beach must comply with all regulations affecting the location and operation of the beach (coastal zone planning and environmental legislation)
- The beach must be clean
- Waste disposal bins/receptacles must be available on/by the beach in adequate numbers, regularly maintained and emptied
- Facilities for receiving recyclable waste materials must be available on/by the beach
- Adequate and clean sanitary facilities with controlled sewage disposal
- On the beach there will be no unauthorized camping or driving and no dumping
- Regulation concerning dogs and other domestic animals on the beach must be strictly enforced
- All buildings and equipment of the beach must be properly maintained
- Sustainable means of transportation must be promoted in the beach area

SAFETY AND SERVICES

- An adequate number of lifeguards and/or lifesaving equipment must be available at the beach
- First aid equipment must be available on the beach
- There must be management of different users and uses of the beach so as to prevent conflicts and accidents
- An emergency plans to cope with pollution safety risks must be in place
- There must be safe access to the beach
- The beach area must be patrolled
- A supply of potable drinking water must be available on the beach
- A minimum of one Blue Flag beach in each municipality must have access and toilet facilities provided for disabled persons
- Map of the beach indicating different facilities must be displayed

APPENDIX 2

SUPPLEMENTARY INFORMATION FOR

CHAPTER III

A. Civil War Onset Estimated With Panel Logit Model

In appendix A I estimate equations (1) and (2) using the panel logit econometric method. I also expand equations (1) by adding up to three lags of a given climate change related disaster event, as well as time fixed effects. Table A0 below relates estimated models to econometric specifications in the paper. Tables A1 through A7 provide estimates of models O1 through O8 for each disaster event. Table A8 provides estimates of models O1 through O8 for all disaster events jointly. Table A1 provides estimates for drought events; A2 for extreme cold temperature events; A3 for extreme heat events; A4 for epidemic outbreaks; A5 for flood events; A6 for storm events; and A7 for wildfire events.

Table A0. Description of Appendix A Tables

Model	Lags on a disaster variable	Equivalence to equations in the paper
O1	0	Equation (1)
O2	1	Equation (1)+Disaster_{t-1}
O3	2	Equation (1)+Disaster_{t-1}+ Disaster_{t-2}
O4	3	Equation (1)+Disaster_{t-1}+ Disaster_{t-2}+ Disaster_{t-3}
O5	0	Equation (2)-Disaster_{t-1}-Disaster_{t-2}-Disaster_{t-3}
O6	1	Equation (2)-Disaster_{t-2}-Disaster_{t-3}
O7	2	Equation (2)-Disaster_{t-3}
O8	3	Equation (2)

Table A1. Determinants of Civil War Onset Controling for Frequency of Drought Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Drought_t$	0.137	-0.0200	0.0283	0.00277	-0.197	-0.268	-0.243	-0.256
	(0.340)	(0.373)	(0.372)	(0.374)	(0.361)	(0.389)	(0.387)	(0.389)
$Drought_{t-1}$	--	0.386	$\boxed{\textbf{0.598*}}$	0.586	--	0.188	0.414	0.406
		(0.346)	(0.364)	(0.365)		(0.361)	(0.379)	(0.380)
$Drought_{t-2}$	--	--	-0.676	-0.790	--	--	-0.741	-0.812
			(0.467)	(0.497)			(0.481)	(0.506)
$Drought_{t-3}$	--	--	--	0.281	--	--	--	0.195
				(0.393)				(0.406)
Prior war	-0.828**	-0.854**	-0.828**	-0.841**	-1.104***	-1.108***	-1.091***	-1.091***
	(0.370)	(0.371)	(0.371)	(0.372)	(0.386)	(0.386)	(0.386)	(0.386)
GDP/capita, lagged	-0.341***	-0.337***	-0.343***	-0.341***	-0.434***	-0.431***	-0.443***	-0.440***
	(0.0734)	(0.0732)	(0.0738)	(0.0737)	(0.0841)	(0.0841)	(0.0855)	(0.0855)
log(Population Density)	0.0880	0.0897	0.0889	0.0889	0.0484	0.0502	0.0484	0.0492
	(0.0862)	(0.0862)	(0.0863)	(0.0862)	(0.0931)	(0.0931)	(0.0935)	(0.0934)
log(% mountains)	0.229***	0.233***	0.228***	0.229***	0.249***	0.251***	0.249***	0.250***
	(0.0847)	(0.0847)	(0.0849)	(0.0848)	(0.0901)	(0.0901)	(0.0905)	(0.0903)
1(Noncontiguous state)	0.697**	0.702**	0.691**	0.696**	0.867***	0.864***	0.870***	0.870***
	(0.278)	(0.278)	(0.278)	(0.278)	(0.313)	(0.312)	(0.313)	(0.313)
1(Oil producer)	0.918***	0.920***	0.916***	0.916***	0.836***	0.841***	0.835***	0.839***
	(0.293)	(0.293)	(0.293)	(0.293)	(0.324)	(0.324)	(0.324)	(0.324)
1(New State)	1.533***	1.556***	1.538***	1.551***	1.424***	1.432***	1.422***	1.429***
	(0.337)	(0.338)	(0.338)	(0.338)	(0.379)	(0.380)	(0.381)	(0.381)
1(Instability)	0.534**	0.533**	0.542**	0.543**	0.465*	0.464*	0.468*	0.469*
	(0.246)	(0.246)	(0.246)	(0.246)	(0.257)	(0.257)	(0.257)	(0.257)
1(PolityIV)	0.0131	0.0128	0.0131	0.0129	0.0232	0.0231	0.0238	0.0238
	(0.0179)	(0.0179)	(0.0179)	(0.0179)	(0.0194)	(0.0194)	(0.0195)	(0.0194)
1(Anocracy)	0.384*	0.394*	0.390*	0.395*	0.483**	0.483**	0.486**	0.485**
	(0.223)	(0.223)	(0.223)	(0.224)	(0.237)	(0.236)	(0.237)	(0.237)
Constant	-4.072***	-4.114***	-4.069***	-4.092***	-3.774***	-3.775***	-3.764***	-3.766***
	(0.443)	(0.445)	(0.445)	(0.447)	(1.150)	(1.150)	(1.151)	(1.150)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table A2. Determinants of Civil War Onset Controling for Frequency of Extreme Cold Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
Extreme Cold$_t$	**1.438*** **	**1.226*** **	**1.178** **	**1.192** **	**1.381*** **	**1.232*** **	**1.209*** **	**1.232*** **
	(0.394)	(0.463)	(0.468)	(0.465)	(0.429)	(0.456)	(0.459)	(0.455)
Extreme Cold$_{t-1}$	--	0.625	0.513	0.506	--	0.675	0.570	0.551
		(0.578)	(0.596)	(0.602)		(0.553)	(0.590)	(0.600)
Extreme Cold$_{t-2}$	--	--	0.487	0.582	--	--	0.339	0.521
			(0.615)	(0.652)			(0.620)	(0.674)
Extreme Cold$_{t-3}$	--	--	--	-0.397	--	--	--	-0.604
				(0.965)				(0.991)
Prior war	-0.875**	-0.900**	-0.922**	-0.913**	-1.152***	-1.177***	-1.198***	-1.196***
	(0.370)	(0.371)	(0.374)	(0.375)	(0.385)	(0.386)	(0.389)	(0.389)
GDP/capita, lagged	-0.359***	-0.359***	-0.361***	-0.362***	-0.438***	-0.439***	-0.438***	-0.438***
	(0.0742)	(0.0745)	(0.0747)	(0.0748)	(0.0835)	(0.0836)	(0.0836)	(0.0835)
log(Population Density)	0.0730	0.0693	0.0672	0.0689	0.0392	0.0348	0.0312	0.0322
	(0.0846)	(0.0845)	(0.0845)	(0.0847)	(0.0912)	(0.0910)	(0.0913)	(0.0915)
log(% mountains)	0.229***	0.233***	0.234***	0.233***	0.252***	0.254***	0.256***	0.256***
	(0.0829)	(0.0829)	(0.0830)	(0.0830)	(0.0883)	(0.0880)	(0.0882)	(0.0883)
1(Noncontiguous state)	0.678**	0.674**	0.675**	0.675**	0.821***	0.812***	0.811***	0.816***
	(0.275)	(0.276)	(0.277)	(0.276)	(0.309)	(0.309)	(0.309)	(0.310)
1(Oil producer)	0.900***	0.892***	0.889***	0.891***	0.834***	0.826***	0.827***	0.830***
	(0.289)	(0.290)	(0.291)	(0.291)	(0.320)	(0.320)	(0.321)	(0.321)
1(New State)	1.554***	1.561***	1.563***	1.562***	1.467***	1.483***	1.489***	1.489***
	(0.334)	(0.334)	(0.335)	(0.335)	(0.377)	(0.378)	(0.378)	(0.378)
1(Instability)	0.547**	0.557**	0.560**	0.558**	0.492*	0.505**	0.510**	0.509**
	(0.244)	(0.244)	(0.244)	(0.244)	(0.256)	(0.256)	(0.256)	(0.256)
1(PolityIV)	0.00987	0.00935	0.00895	0.00936	0.0205	0.0197	0.0194	0.0199
	(0.0179)	(0.0179)	(0.0180)	(0.0180)	(0.0194)	(0.0194)	(0.0195)	(0.0194)
1(Anocracy)	0.374*	0.371*	0.371*	0.367*	0.470**	0.468**	0.472**	0.467**
	(0.220)	(0.220)	(0.221)	(0.221)	(0.235)	(0.235)	(0.235)	(0.235)
Constant	-4.092***	-4.115***	-4.127***	-4.115***	-3.755***	-3.765***	-3.789***	-3.787***
	(0.428)	(0.427)	(0.427)	(0.429)	(1.141)	(1.140)	(1.141)	(1.142)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table A3. Determinants of Civil War Onset Controling for Frequency of Extreme Heat Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
Extreme Heat$_t$	-16.41	-16.24	-16.34	-16.16	-18.78	-18.95	-18.71	-19.13
	(3,788)	(2,734)	(2,742)	(2,646)	(12,268)	(12,782)	(11,329)	(13,815)
Extreme Heat$_{t-1}$	--	**1.427****	**1.098***	**1.120***	--	**1.581****	1.225	**1.273***
		(0.611)	(0.665)	(0.664)		(0.678)	(0.780)	(0.758)
Extreme Heat$_{t-2}$	--	--	**1.091***	0.752	--	--	0.849	0.545
			(0.648)	(0.684)			(0.768)	(0.790)
Extreme Heat$_{t-3}$	--	--	--	**1.102***	--	--	--	**1.135***
				(0.653)				(0.681)
Prior war	-0.798**	-0.834**	-0.874**	-0.907**	-1.100***	-1.142***	-1.165***	-1.196***
	(0.365)	(0.371)	(0.374)	(0.374)	(0.385)	(0.388)	(0.390)	(0.391)
GDP/capita, lagged	-0.344***	-0.343***	-0.340***	-0.338***	-0.431***	-0.432***	-0.428***	-0.427***
	(0.0737)	(0.0731)	(0.0728)	(0.0728)	(0.0835)	(0.0831)	(0.0831)	(0.0830)
log(Population Density)	0.0915	0.0836	0.0776	0.0738	0.0560	0.0458	0.0416	0.0373
	(0.0865)	(0.0866)	(0.0867)	(0.0873)	(0.0930)	(0.0930)	(0.0932)	(0.0935)
log(% mountains)	0.229***	0.224***	0.225***	0.224***	0.253***	0.249***	0.250***	0.250***
	(0.0848)	(0.0849)	(0.0848)	(0.0852)	(0.0901)	(0.0899)	(0.0899)	(0.0901)
1(Noncontiguous state)	0.695**	0.687**	0.671**	0.655**	0.865***	0.846***	0.830***	0.803**
	(0.278)	(0.279)	(0.281)	(0.284)	(0.313)	(0.313)	(0.315)	(0.317)
1(Oil producer)	0.922***	0.913***	0.907***	0.911***	0.844***	0.851***	0.849***	0.854***
	(0.294)	(0.294)	(0.293)	(0.295)	(0.324)	(0.323)	(0.323)	(0.323)
1(New State)	1.511***	1.532***	1.545***	1.554***	1.429***	1.441***	1.444***	1.459***
	(0.336)	(0.336)	(0.336)	(0.336)	(0.379)	(0.379)	(0.379)	(0.379)
1(Instability)	0.527**	0.533**	0.555**	0.557**	0.466*	0.483*	0.501*	0.509**
	(0.246)	(0.246)	(0.246)	(0.246)	(0.258)	(0.257)	(0.258)	(0.258)
1(PolityIV)	0.0144	0.0119	0.0105	0.00892	0.0245	0.0215	0.0207	0.0191
	(0.0179)	(0.0180)	(0.0182)	(0.0183)	(0.0195)	(0.0196)	(0.0197)	(0.0198)
1(Anocracy)	0.377*	0.386*	0.397*	0.411*	0.479**	0.491**	0.492**	0.502**
	(0.223)	(0.223)	(0.223)	(0.224)	(0.237)	(0.237)	(0.237)	(0.237)
Constant	-4.033***	-4.070***	-4.110***	-4.141***	-3.762***	-3.778***	-3.792***	-3.801***
	(0.441)	(0.440)	(0.441)	(0.443)	(1.150)	(1.149)	(1.149)	(1.149)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table A4. Determinants of Civil War Onset Controling for Frequency Epidemic Outbreaks, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Epidemic_t$	**0.380****	**0.305***	**0.299***	**0.299***	**0.379****	**0.351***	**0.346***	**0.348***
	(0.151)	(0.171)	(0.173)	(0.174)	(0.181)	(0.191)	(0.192)	(0.193)
$Epidemic_{t-1}$	--	0.218	0.200	0.200	--	0.112	0.0940	0.0971
		(0.216)	(0.229)	(0.229)		(0.238)	(0.244)	(0.244)
$Epidemic_{t-2}$	--	--	0.0619	0.0611	--	--	0.0932	0.101
			(0.263)	(0.268)			(0.275)	(0.280)
$Epidemic_{t-3}$	--	--	--	0.00523	--	--	--	-0.0492
				(0.308)				(0.318)
Prior war	-0.913**	-0.947**	-0.955**	-0.956**	-1.165***	-1.178***	-1.185***	-1.183***
	(0.376)	(0.380)	(0.382)	(0.383)	(0.394)	(0.397)	(0.398)	(0.398)
GDP/capita, lagged	-0.331***	-0.329***	-0.328***	-0.328***	-0.411***	-0.408***	-0.407***	-0.408***
	(0.0732)	(0.0731)	(0.0731)	(0.0732)	(0.0826)	(0.0826)	(0.0827)	(0.0830)
log(Population Density)	0.0714	0.0687	0.0680	0.0679	0.0419	0.0402	0.0392	0.0399
	(0.0866)	(0.0869)	(0.0869)	(0.0871)	(0.0921)	(0.0922)	(0.0923)	(0.0925)
log(% mountains)	0.242***	0.245***	0.246***	0.246***	0.258***	0.259***	0.261***	0.261***
	(0.0852)	(0.0856)	(0.0856)	(0.0857)	(0.0895)	(0.0896)	(0.0899)	(0.0899)
1(Noncontiguous state)	0.725***	0.734***	0.735***	0.735***	0.860***	0.859***	0.857***	0.858***
	(0.280)	(0.281)	(0.281)	(0.281)	(0.310)	(0.310)	(0.310)	(0.310)
1(Oil producer)	0.873***	0.874***	0.875***	0.875***	0.824***	0.825***	0.825***	0.827***
	(0.294)	(0.294)	(0.294)	(0.295)	(0.320)	(0.319)	(0.319)	(0.320)
1(New State)	1.579***	1.595***	1.598***	1.598***	1.478***	1.485***	1.489***	1.487***
	(0.337)	(0.337)	(0.338)	(0.338)	(0.378)	(0.378)	(0.378)	(0.379)
1(Instability)	0.521**	0.525**	0.526**	0.527**	0.470*	0.473*	0.476*	0.475*
	(0.247)	(0.247)	(0.247)	(0.247)	(0.256)	(0.256)	(0.257)	(0.257)
1(PolityIV)	0.0112	0.0108	0.0107	0.0107	0.0224	0.0223	0.0223	0.0224
	(0.0180)	(0.0180)	(0.0180)	(0.0180)	(0.0193)	(0.0194)	(0.0194)	(0.0194)
1(Anocracy)	0.370*	0.364	0.364	0.364	0.486**	0.484**	0.484**	0.483**
	(0.223)	(0.223)	(0.223)	(0.223)	(0.236)	(0.237)	(0.237)	(0.237)
Constant	-4.212***	-4.250***	-4.257***	-4.258***	-3.846***	-3.858***	-3.869***	-3.866***
	(0.448)	(0.450)	(0.452)	(0.454)	(1.148)	(1.149)	(1.149)	(1.150)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table A5. Determinant of Civil War Onset Controling for Frequency of Flood Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Flood_t$	0.181	0.113	0.0847	0.0512	0.154	0.113	0.0915	0.0634
	(0.118)	(0.137)	(0.143)	(0.146)	(0.130)	(0.146)	(0.150)	(0.152)
$Flood_{t-1}$	--	0.146	0.0987	0.0710	--	0.0945	0.0501	0.0285
		(0.141)	(0.152)	(0.157)		(0.146)	(0.157)	(0.161)
$Flood_{t-2}$	--	--	0.127	0.0744	--	--	0.121	0.0772
			(0.149)	(0.157)			(0.157)	(0.162)
$Flood_{t-3}$	--	--	--	0.164	--	--	--	0.148
				(0.150)				(0.151)
Prior war	-0.879**	-0.905**	-0.930**	-0.958**	-1.138***	-1.151***	-1.172***	-1.189***
	(0.377)	(0.383)	(0.387)	(0.391)	(0.389)	(0.391)	(0.393)	(0.395)
GDP/capita, lagged	-0.345***	-0.345***	-0.346***	-0.346***	-0.426***	-0.425***	-0.425***	-0.423***
	(0.0734)	(0.0734)	(0.0735)	(0.0737)	(0.0828)	(0.0827)	(0.0827)	(0.0827)
log(Population Density)	0.0687	0.0608	0.0553	0.0505	0.0398	0.0335	0.0285	0.0233
	(0.0859)	(0.0859)	(0.0861)	(0.0863)	(0.0917)	(0.0919)	(0.0920)	(0.0921)
log(% mountains)	0.219***	0.215***	0.213**	0.212**	0.241***	0.237***	0.234***	0.233***
	(0.0835)	(0.0831)	(0.0830)	(0.0830)	(0.0886)	(0.0883)	(0.0881)	(0.0880)
1(Noncontiguous state)	0.690**	0.684**	0.682**	0.678**	0.836***	0.825***	0.817***	0.808***
	(0.274)	(0.273)	(0.273)	(0.274)	(0.307)	(0.307)	(0.306)	(0.306)
1(Oil producer)	0.886***	0.876***	0.872***	0.866***	0.833***	0.832***	0.829***	0.826***
	(0.288)	(0.286)	(0.286)	(0.286)	(0.317)	(0.315)	(0.314)	(0.314)
1(New State)	1.554***	1.573***	1.584***	1.594***	1.448***	1.457***	1.463***	1.480***
	(0.335)	(0.335)	(0.335)	(0.336)	(0.376)	(0.376)	(0.376)	(0.376)
1(Instability)	0.531**	0.529**	0.537**	0.541**	0.470*	0.472*	0.477*	0.479*
	(0.245)	(0.244)	(0.244)	(0.244)	(0.256)	(0.255)	(0.255)	(0.255)
1(PolityIV)	0.0110	0.0104	0.0101	0.00981	0.0213	0.0211	0.0209	0.0208
	(0.0179)	(0.0179)	(0.0179)	(0.0179)	(0.0193)	(0.0193)	(0.0193)	(0.0193)
1(Anocracy)	0.404*	0.420*	0.430*	0.440**	0.501**	0.511**	0.518**	0.525**
	(0.222)	(0.223)	(0.223)	(0.223)	(0.236)	(0.236)	(0.236)	(0.236)
Constant	-4.134***	-4.168***	-4.192***	-4.216***	-3.767***	-3.777***	-3.784***	-3.801***
	(0.438)	(0.438)	(0.439)	(0.441)	(1.144)	(1.143)	(1.142)	(1.142)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table A6. Determinants of Civil War Onset Controling for Frequency of Storm Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Storm_t$	0.0958	0.00514	-0.0763	0.00134	0.0596	-0.0143	-0.109	0.0146
	(0.114)	(0.155)	(0.171)	(0.181)	(0.123)	(0.157)	(0.177)	(0.185)
$Storm_{t-1}$	--	0.138	0.0225	0.0710	--	0.120	0.00334	0.0672
		(0.143)	(0.163)	(0.163)		(0.146)	(0.166)	(0.166)
$Storm_{t-2}$	--	--	**0.235***	**0.316****	--	--	0.249	**0.353****
			(0.139)	(0.154)			(0.154)	(0.169)
$Storm_{t-3}$	--	--	--	-0.300	--	--	--	-0.416
				(0.234)				(0.255)
Prior war	-0.847**	-0.876**	-0.916**	-0.896**	-1.129***	-1.148***	-1.180***	-1.178***
	(0.370)	(0.372)	(0.373)	(0.372)	(0.387)	(0.388)	(0.391)	(0.391)
GDP/capita, lagged	-0.345***	-0.347***	-0.352***	-0.351***	-0.429***	-0.429***	-0.430***	-0.435***
	(0.0731)	(0.0730)	(0.0724)	(0.0722)	(0.0829)	(0.0826)	(0.0821)	(0.0823)
log(Population Density)	0.0756	0.0701	0.0645	0.0669	0.0444	0.0383	0.0309	0.0344
	(0.0869)	(0.0870)	(0.0870)	(0.0870)	(0.0936)	(0.0937)	(0.0936)	(0.0941)
log(% mountains)	0.226***	0.225***	0.226***	0.226***	0.249***	0.248***	0.249***	0.251***
	(0.0843)	(0.0844)	(0.0846)	(0.0845)	(0.0895)	(0.0894)	(0.0894)	(0.0899)
1(Noncontiguous state)	0.671**	0.660**	0.646**	0.657**	0.845***	0.832***	0.810**	0.835***
	(0.279)	(0.280)	(0.282)	(0.281)	(0.314)	(0.314)	(0.315)	(0.317)
1(Oil producer)	0.929***	0.937***	0.946***	0.943***	0.851***	0.858***	0.864***	0.862***
	(0.292)	(0.292)	(0.293)	(0.293)	(0.322)	(0.322)	(0.322)	(0.323)
1(New State)	1.533***	1.541***	1.546***	1.550***	1.439***	1.451***	1.458***	1.463***
	(0.335)	(0.335)	(0.335)	(0.335)	(0.378)	(0.378)	(0.378)	(0.379)
1(Instability)	0.538**	0.543**	0.550**	0.541**	0.470*	0.471*	0.480*	0.471*
	(0.245)	(0.245)	(0.245)	(0.246)	(0.257)	(0.256)	(0.256)	(0.258)
1(PolityIV)	0.0123	0.0120	0.0118	0.0116	0.0224	0.0223	0.0217	0.0227
	(0.0179)	(0.0179)	(0.0179)	(0.0180)	(0.0194)	(0.0194)	(0.0194)	(0.0195)
1(Anocracy)	0.391*	0.397*	0.407*	0.396*	0.492**	0.496**	0.505**	0.489**
	(0.223)	(0.223)	(0.224)	(0.224)	(0.237)	(0.237)	(0.237)	(0.238)
Constant	-4.102***	-4.126***	-4.151***	-4.139***	-3.788***	-3.800***	-3.821***	-3.815***
	(0.442)	(0.442)	(0.440)	(0.440)	(1.149)	(1.149)	(1.150)	(1.151)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table A7. Determinants of Civil War Onset Controling for Frequency of Wildfire Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
Wildfire$_t$	**1.247*** **	**1.235** **	**1.125** **	**1.153** **	**1.234** **	**1.218** **	**1.133** **	**1.133** **
	(0.448)	(0.482)	(0.512)	(0.513)	(0.499)	(0.514)	(0.529)	(0.534)
Wildfire$_{t-1}$	--	0.0518	-0.146	-0.135	--	0.109	-0.0849	-0.0847
		(0.766)	(0.822)	(0.813)		(0.772)	(0.817)	(0.817)
Wildfire$_{t-2}$	--	--	0.671	0.737	--	--	0.789	0.790
			(0.659)	(0.678)			(0.671)	(0.684)
Wildfire$_{t-3}$	--	--	--	-0.408	--	--	--	-0.00807
				(1.222)				(1.154)
Prior war	-0.821**	-0.821**	-0.805**	-0.807**	-1.090***	-1.086***	-1.066***	-1.066***
	(0.371)	(0.371)	(0.372)	(0.371)	(0.388)	(0.389)	(0.388)	(0.388)
GDP/capita, lagged	-0.365***	-0.366***	-0.371***	-0.370***	-0.447***	-0.447***	-0.452***	-0.452***
	(0.0748)	(0.0751)	(0.0752)	(0.0752)	(0.0839)	(0.0840)	(0.0837)	(0.0838)
log(Population Density)	0.0921	0.0923	0.0944	0.0943	0.0572	0.0581	0.0627	0.0627
	(0.0858)	(0.0858)	(0.0855)	(0.0855)	(0.0917)	(0.0918)	(0.0912)	(0.0912)
log(% mountains)	0.220***	0.219***	0.218***	0.218***	0.241***	0.240***	0.236***	0.236***
	(0.0839)	(0.0839)	(0.0835)	(0.0836)	(0.0887)	(0.0887)	(0.0881)	(0.0881)
1(Noncontiguous state)	0.678**	0.677**	0.669**	0.672**	0.837***	0.834***	0.823***	0.823***
	(0.276)	(0.277)	(0.276)	(0.276)	(0.308)	(0.309)	(0.307)	(0.307)
1(Oil producer)	0.907***	0.907***	0.903***	0.903***	0.842***	0.842***	0.846***	0.845***
	(0.290)	(0.290)	(0.289)	(0.289)	(0.319)	(0.319)	(0.317)	(0.317)
1(New State)	1.552***	1.552***	1.559***	1.558***	1.467***	1.468***	1.471***	1.471***
	(0.335)	(0.335)	(0.335)	(0.335)	(0.377)	(0.377)	(0.376)	(0.376)
1(Instability)	0.536**	0.536**	0.541**	0.540**	0.471*	0.472*	0.475*	0.475*
	(0.245)	(0.245)	(0.245)	(0.245)	(0.257)	(0.257)	(0.256)	(0.256)
1(PolityIV)	0.0107	0.0107	0.0106	0.0107	0.0212	0.0212	0.0210	0.0210
	(0.0179)	(0.0179)	(0.0179)	(0.0179)	(0.0193)	(0.0193)	(0.0193)	(0.0193)
1(Anocracy)	0.378*	0.377*	0.369*	0.368*	0.481**	0.480**	0.473**	0.473**
	(0.222)	(0.222)	(0.222)	(0.222)	(0.236)	(0.236)	(0.236)	(0.236)
Constant	-4.001***	-3.999***	-3.979***	-3.981***	-3.664***	-3.656***	-3.604***	-3.604***
	(0.436)	(0.437)	(0.436)	(0.436)	(1.144)	(1.145)	(1.143)	(1.143)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table A8. Determinants of Civil War Onset Controling for Frequency of All Disaster Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Drought_t$	-0.00316	-0.0480	-0.0143	-0.0798	-0.258	-0.248	-0.207	-0.258
	(0.344)	(0.373)	(0.374)	(0.387)	(0.361)	(0.388)	(0.387)	(0.398)
$Drought_{t-1}$	--	0.198	0.453	0.460	--	0.0893	0.334	0.309
		(0.357)	(0.376)	(0.378)		(0.367)	(0.390)	(0.391)
$Drought_{t-2}$	--	--	-0.787	-0.786	--	--	**-0.862***	-0.810
			(0.482)	(0.502)			(0.503)	(0.524)
$Drought_{t-3}$	--	--	--	0.105	--	--	--	0.0830
				(0.411)				(0.426)
Extreme $Cold_t$	**1.205*****	**0.928***	0.762	**0.913***	**1.226*****	**0.949***	0.797	**1.028***
	(0.461)	(0.511)	(0.552)	(0.546)	(0.468)	(0.542)	(0.578)	(0.567)
Extreme $Cold_{t-1}$	--	0.495	0.354	0.213	--	0.521	0.462	0.351
		(0.609)	(0.668)	(0.740)		(0.611)	(0.674)	(0.754)
Extreme $Cold_{t-2}$	--	--	0.333	0.163	--	--	0.184	-0.120
			(0.714)	(0.875)			(0.734)	(0.957)
Extreme $Cold_{t-3}$	--	--	--	-0.475	--	--	--	-0.421
				(1.131)				(1.179)
Extreme $Heat_t$	-19.42	-18.50	-17.63	-17.95	-18.13	-19.33	-19.29	-19.99
	(12,271)	(6,318)	(3,762)	(3,727)	(7,498)	(13,656)	(12,977)	(18,211)
Extreme $Heat_{t-1}$	--	0.955	0.763	0.998	--	1.181	0.971	**1.400***
		(0.678)	(0.707)	(0.690)		(0.793)	(0.822)	(0.788)
Extreme $Heat_{t-2}$	--	--	0.791	0.751	--	--	0.709	0.576
			(0.751)	(0.803)			(0.809)	(0.858)
Extreme $Heat_{t-3}$	--	--	--	0.699	--	--	--	1.084
				(0.804)				(0.855)
$Epidemic_t$	**0.300***	0.259	0.291	0.277	**0.345***	**0.357***	**0.388***	**0.391***
	(0.169)	(0.186)	(0.188)	(0.192)	(0.193)	(0.207)	(0.211)	(0.219)
$Epidemic_{t-1}$	--	0.148	0.176	0.247	--	-0.0255	-0.00419	0.0640
		(0.228)	(0.241)	(0.242)		(0.267)	(0.273)	(0.274)
$Epidemic_{t-2}$	--	--	-0.0989	-0.155	--	--	-0.0590	-0.0861
			(0.300)	(0.315)			(0.313)	(0.330)
$Epidemic_{t-3}$	--	--	--	-0.173	--	--	--	-0.294
				(0.350)				(0.382)
$Flood_t$	0.0923	0.0368	0.0408	-0.0157	0.0940	0.0481	0.0521	-0.0112
	(0.135)	(0.153)	(0.156)	(0.160)	(0.140)	(0.160)	(0.165)	(0.171)
$Flood_{t-1}$	--	0.00842	-0.0550	0.0142	--	-0.00929	-0.0769	0.0259
		(0.163)	(0.172)	(0.178)		(0.168)	(0.178)	(0.187)
$Flood_{t-2}$	--	--	0.0579	0.0298	--	--	0.0548	0.0246
			(0.169)	(0.174)			(0.180)	(0.182)
$Flood_{t-3}$	--	--	--	0.119	--	--	--	0.140
				(0.175)				(0.180)
$Storm_t$	0.00830	-0.0979	-0.175	-0.0244	0.00525	-0.0792	-0.166	0.0147
	(0.135)	(0.177)	(0.195)	(0.197)	(0.138)	(0.179)	(0.199)	(0.196)
$Storm_{t-1}$	--	0.118	0.00321	0.0138	--	0.0969	-0.0225	-0.0144
		(0.154)	(0.175)	(0.179)		(0.159)	(0.178)	(0.185)
$Storm_{t-2}$	--	--	0.218	**0.358****	--	--	0.238	**0.417****
			(0.147)	(0.165)			(0.154)	(0.175)
$Storm_{t-3}$	--	--	--	**-0.478***	--	--	--	**-0.624****
				(0.248)				(0.281)
$Wildfire_t$	0.657	0.726	0.641	0.819	0.812	0.834	0.756	0.898
	(0.526)	(0.553)	(0.576)	(0.590)	(0.540)	(0.562)	(0.580)	(0.603)
$Wildfire_{t-1}$	--	-0.353	-0.456	-0.397	--	-0.133	-0.279	-0.119
		(0.871)	(0.949)	(0.963)		(0.853)	(0.921)	(0.933)
$Wildfire_{t-2}$	--	--	0.297	0.447	--	--	0.507	0.529
			(0.764)	(0.795)			(0.762)	(0.795)
$Wildfire_{t-3}$	--	--	--	-1.101	--	--	--	-0.656
				(1.659)				(1.523)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models that include the full set of control variables (same as in Tables). Standard errors in parentheses. Control variable estimates are not displayed. *** p<0.01, ** p<0.05, * p<0.1.

B. Civil War Onset Estimated With Conditional (Fixed Effects) Logit Model

In appendix B I estimate equations (1) and (2) using the conditional (fixed effects) logit econometric method. I also expand equations (1) by adding up to three lags of a given climate change related disaster event, as well as time fixed effects. Table B0 below relates estimated models to econometric specifications in the paper. Tables B1 through B7 provide estimates of models O1 through O8 for each disaster event. Table B8 provides estimates of models O1 through O8 for all disaster events jointly. Table B1 provides estimates for drought events; B2 for extreme cold temperature events; B3 for extreme heat events; B4 for epidemic outbreaks; B5 for flood events; B6 for storm events; and B7 for wildfire events.

Table B0. Description of Appendix B Tables

Model	Lags on a disaster variable	Equivalence to equations in the paper
O1	0	Equation (1)
O2	1	Equation (1)+Disaster_{t-1}
O3	2	Equation (1)+Disaster_{t-1}+ Disaster_{t-2}
O4	3	Equation (1)+Disaster_{t-1}+ Disaster_{t-2}+ Disaster_{t-3}
O5	0	Equation (2)-Disaster_{t-1}-Disaster_{t-2}-Disaster_{t-3}
O6	1	Equation (2)-Disaster_{t-2}-Disaster_{t-3}
O7	2	Equation (2)-Disaster_{t-3}
O8	3	Equation (2)

Table B1. Determinants of Civil War Onset Controling for Frequency of Drought Events, 1945-1999 (n=2736)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Drought_t$	-0.115	-0.169	-0.141	-0.148	-0.261	-0.299	-0.277	-0.284
	(0.365)	(0.378)	(0.377)	(0.378)	(0.391)	(0.405)	(0.402)	(0.404)
$Drought_{t-1}$	--	0.204	0.418	0.418	--	0.143	0.334	0.334
		(0.353)	(0.362)	(0.363)		(0.373)	(0.385)	(0.385)
$Drought_{t-2}$	--	--	**-0.829***	**-0.861***	--	--	-0.754	-0.793
			(0.476)	(0.500)			(0.487)	(0.510)
$Drought_{t-3}$	--	--	--	0.0877	--	--	--	0.115
				(0.412)				(0.428)
Prior war	-2.344***	-2.355***	-2.330***	-2.333***	-2.354***	-2.359***	-2.336***	-2.336***
	(0.390)	(0.391)	(0.391)	(0.391)	(0.403)	(0.403)	(0.403)	(0.403)
GDP/capita, lagged	-0.123	-0.121	-0.127	-0.127	-0.237	-0.231	-0.247	-0.244
	(0.155)	(0.155)	(0.156)	(0.156)	(0.195)	(0.196)	(0.197)	(0.197)
log(Population Density)	1.235***	1.211***	1.287***	1.275***	0.286	0.315	0.287	0.295
	(0.424)	(0.427)	(0.427)	(0.431)	(1.092)	(1.095)	(1.093)	(1.094)
1(Noncontiguous state)	-1.653	-1.655	-1.657	-1.658	-0.985	-1.016	-0.935	-0.953
	(1.273)	(1.274)	(1.274)	(1.274)	(1.510)	(1.513)	(1.513)	(1.514)
1(Oil producer)	0.719	0.706	0.679	0.681	0.629	0.631	0.599	0.603
	(0.727)	(0.727)	(0.730)	(0.731)	(0.784)	(0.783)	(0.783)	(0.785)
1(New State)	1.637***	1.645***	1.643***	1.644***	1.485***	1.485***	1.491***	1.490***
	(0.423)	(0.424)	(0.424)	(0.424)	(0.513)	(0.513)	(0.514)	(0.514)
1(Instability)	0.582**	0.584**	0.585**	0.586**	0.572**	0.573**	0.578**	0.580**
	(0.280)	(0.281)	(0.280)	(0.280)	(0.289)	(0.289)	(0.289)	(0.289)
1(PolityIV)	-0.00210	-0.00166	-0.00368	-0.00350	0.00487	0.00506	0.00493	0.00512
	(0.0264)	(0.0265)	(0.0264)	(0.0264)	(0.0296)	(0.0296)	(0.0296)	(0.0296)
1(Anocracy)	0.664**	0.665**	0.672**	0.672**	0.673**	0.671**	0.675**	0.675**
	(0.278)	(0.278)	(0.277)	(0.277)	(0.287)	(0.287)	(0.287)	(0.287)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table B2. Determinants of Civil War Onset Controling for Frequency of Extreme Cold Events, 1945-1999 (n=2736)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
Extreme Cold$_t$	**1.127****	**1.016****	**1.019****	**1.027****	**1.183****	**1.128****	**1.133****	**1.140****
	(0.465)	(0.505)	(0.509)	(0.506)	(0.510)	(0.519)	(0.522)	(0.518)
Extreme Cold$_{t-1}$	--	0.386	0.303	0.261	--	0.481	0.430	0.367
		(0.610)	(0.618)	(0.625)		(0.597)	(0.618)	(0.627)
Extreme Cold$_{t-2}$	--	--	0.447	0.592	--	--	0.202	0.411
			(0.626)	(0.663)			(0.632)	(0.675)
Extreme Cold$_{t-3}$	--	--	--	-0.618	--	--	--	-0.778
				(0.984)				(0.984)
Prior war	-2.416***	-2.426***	-2.442***	-2.438***	-2.381***	-2.391***	-2.397***	-2.399***
	(0.397)	(0.398)	(0.400)	(0.399)	(0.405)	(0.406)	(0.407)	(0.407)
GDP/capita, lagged	-0.122	-0.122	-0.121	-0.121	-0.179	-0.168	-0.165	-0.174
	(0.157)	(0.157)	(0.158)	(0.157)	(0.193)	(0.194)	(0.194)	(0.195)
log(Population Density)	1.200***	1.195***	1.187***	1.195***	0.834	0.968	0.983	0.878
	(0.424)	(0.425)	(0.425)	(0.425)	(1.120)	(1.139)	(1.141)	(1.145)
1(Noncontiguous state)	-1.534	-1.515	-1.500	-1.510	-1.361	-1.393	-1.394	-1.341
	(1.279)	(1.279)	(1.279)	(1.280)	(1.516)	(1.520)	(1.520)	(1.522)
1(Oil producer)	0.560	0.535	0.519	0.530	0.533	0.506	0.501	0.517
	(0.750)	(0.754)	(0.758)	(0.757)	(0.804)	(0.808)	(0.808)	(0.807)
1(New State)	1.653***	1.658***	1.661***	1.658***	1.444***	1.437***	1.441***	1.449***
	(0.423)	(0.423)	(0.423)	(0.423)	(0.515)	(0.516)	(0.517)	(0.516)
1(Instability)	0.600**	0.608**	0.617**	0.613**	0.590**	0.598**	0.602**	0.599**
	(0.278)	(0.278)	(0.279)	(0.279)	(0.288)	(0.288)	(0.288)	(0.289)
1(PolityIV)	-0.00686	-0.00731	-0.00810	-0.00726	0.00507	0.00525	0.00530	0.00566
	(0.0264)	(0.0265)	(0.0265)	(0.0265)	(0.0297)	(0.0298)	(0.0298)	(0.0298)
1(Anocracy)	0.642**	0.633**	0.632**	0.629**	0.655**	0.649**	0.651**	0.647**
	(0.277)	(0.277)	(0.278)	(0.278)	(0.285)	(0.286)	(0.286)	(0.286)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table B3. Determinants of Civil War Onset Controling for Frequency of Extreme Heat Events, 1945-1999 (n=2736)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
Extreme Heat$_t$	-12.84	-12.89	-12.98	-14.09	-16.90	-16.52	-16.44	-15.99
	(491.0)	(444.2)	(491.3)	(908.1)	(3,558)	(3,202)	(3,268)	(2,703)
Extreme Heat$_{t-1}$	--	**1.118***	0.955	**1.216***	--	1.159	0.932	1.166
		(0.672)	(0.700)	(0.721)		(0.751)	(0.813)	(0.830)
Extreme Heat$_{t-2}$	--	--	0.787	0.492	--	--	0.639	0.455
			(0.708)	(0.750)			(0.800)	(0.830)
Extreme Heat$_{t-3}$	--	--	--	1.095	--	--	--	0.976
				(0.725)				(0.783)
Prior war	-2.329***	-2.361***	-2.379***	-2.401***	-2.355***	-2.368***	-2.376***	-2.382***
	(0.387)	(0.391)	(0.393)	(0.397)	(0.402)	(0.402)	(0.403)	(0.404)
GDP/capita, lagged	-0.119	-0.124	-0.123	-0.126	-0.219	-0.231	-0.224	-0.211
	(0.156)	(0.154)	(0.154)	(0.154)	(0.195)	(0.195)	(0.194)	(0.194)
log(Population Density)	1.231***	1.230***	1.209***	1.207***	0.319	0.374	0.412	0.591
	(0.422)	(0.422)	(0.423)	(0.424)	(1.091)	(1.092)	(1.093)	(1.106)
1(Noncontiguous state)	-1.788	-1.632	-1.588	-1.546	-1.286	-1.152	-1.121	-1.196
	(1.276)	(1.283)	(1.281)	(1.282)	(1.515)	(1.524)	(1.517)	(1.517)
1(Oil producer)	0.716	0.717	0.717	0.690	0.619	0.664	0.672	0.659
	(0.727)	(0.728)	(0.729)	(0.732)	(0.786)	(0.790)	(0.793)	(0.794)
1(New State)	1.651***	1.650***	1.642***	1.643***	1.491***	1.492***	1.480***	1.464***
	(0.423)	(0.423)	(0.423)	(0.423)	(0.512)	(0.512)	(0.512)	(0.512)
1(Instability)	0.586**	0.593**	0.603**	0.614**	0.590**	0.610**	0.616**	0.626**
	(0.280)	(0.280)	(0.280)	(0.279)	(0.288)	(0.288)	(0.288)	(0.288)
1(PolityIV)	-0.00147	-0.00225	-0.00261	-0.00295	0.00494	0.00316	0.00357	0.00390
	(0.0265)	(0.0264)	(0.0264)	(0.0264)	(0.0296)	(0.0297)	(0.0297)	(0.0298)
1(Anocracy)	0.657**	0.661**	0.663**	0.657**	0.663**	0.665**	0.669**	0.662**
	(0.278)	(0.278)	(0.278)	(0.279)	(0.287)	(0.286)	(0.287)	(0.287)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table B4. Determinants of Civil War Onset Controling for Frequency Epidemic Outbreaks, 1945-1999 (n=2736)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Epidemic_t$	0.267	0.232	0.229	0.235	0.302	0.287	0.285	0.287
	(0.172)	(0.178)	(0.178)	(0.180)	(0.193)	(0.195)	(0.195)	(0.196)
$Epidemic_{t-1}$		0.166	0.153	0.158		0.120	0.105	0.110
		(0.220)	(0.226)	(0.227)		(0.246)	(0.248)	(0.248)
$Epidemic_{t-2}$			0.0648	0.0793			0.121	0.135
			(0.273)	(0.276)			(0.293)	(0.296)
$Epidemic_{t-3}$				-0.110				-0.136
				(0.326)				(0.329)
Prior war	-2.408***	-2.436***	-2.445***	-2.439***	-2.436***	-2.454***	-2.466***	-2.462***
	(0.395)	(0.400)	(0.402)	(0.402)	(0.411)	(0.414)	(0.417)	(0.416)
GDP/capita, lagged	-0.104	-0.0994	-0.0987	-0.101	-0.214	-0.210	-0.208	-0.213
	(0.154)	(0.154)	(0.154)	(0.154)	(0.195)	(0.195)	(0.196)	(0.196)
log(Population Density)	1.073**	1.023**	1.013**	1.032**	0.303	0.303	0.305	0.303
	(0.434)	(0.440)	(0.442)	(0.445)	(1.097)	(1.098)	(1.099)	(1.099)
1(Noncontiguous state)	-1.655	-1.654	-1.657	-1.654	-1.101	-1.120	-1.147	-1.120
	(1.274)	(1.274)	(1.274)	(1.274)	(1.508)	(1.509)	(1.510)	(1.511)
1(Oil producer)	0.731	0.757	0.763	0.766	0.629	0.658	0.681	0.684
	(0.729)	(0.728)	(0.728)	(0.729)	(0.787)	(0.785)	(0.785)	(0.786)
1(New State)	1.655***	1.659***	1.661***	1.661***	1.484***	1.484***	1.481***	1.484***
	(0.422)	(0.422)	(0.422)	(0.422)	(0.513)	(0.514)	(0.514)	(0.514)
1(Instability)	0.592**	0.605**	0.607**	0.606**	0.583**	0.588**	0.595**	0.595**
	(0.280)	(0.281)	(0.281)	(0.281)	(0.289)	(0.289)	(0.290)	(0.290)
1(PolityIV)	-0.00412	-0.00477	-0.00479	-0.00497	0.00467	0.00483	0.00548	0.00507
	(0.0265)	(0.0265)	(0.0265)	(0.0265)	(0.0296)	(0.0297)	(0.0297)	(0.0297)
1(Anocracy)	0.655**	0.650**	0.648**	0.650**	0.686**	0.682**	0.679**	0.678**
	(0.278)	(0.279)	(0.279)	(0.279)	(0.288)	(0.288)	(0.289)	(0.288)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table B5. Determinants of Civil War Onset Controling for Frequency of Flood Events, 1945-1999 (n=2736)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Flood_t$	-0.0408	-0.0431	-0.0454	-0.0661	-0.0475	-0.0425	-0.0455	-0.0615
	(0.136)	(0.145)	(0.147)	(0.151)	(0.146)	(0.153)	(0.155)	(0.157)
$Flood_{t-1}$	--	0.00685	0.00263	-0.00977	--	-0.0158	-0.0258	-0.0343
		(0.148)	(0.154)	(0.157)		(0.153)	(0.161)	(0.164)
$Flood_{t-2}$	--	--	0.0152	-0.0146	--	--	0.0318	0.00685
			(0.154)	(0.159)			(0.165)	(0.169)
$Flood_{t-3}$	--	--	--	0.106	--	--	--	0.0973
				(0.151)				(0.151)
Prior war	-2.339***	-2.340***	-2.343***	-2.362***	-2.361***	-2.359***	-2.364***	-2.374***
	(0.391)	(0.392)	(0.393)	(0.396)	(0.403)	(0.404)	(0.404)	(0.406)
GDP/capita, lagged	-0.123	-0.123	-0.123	-0.125	-0.232	-0.233	-0.233	-0.230
	(0.155)	(0.155)	(0.155)	(0.155)	(0.195)	(0.196)	(0.196)	(0.196)
log(Population Density)	1.253***	1.250***	1.243***	1.205***	0.278	0.266	0.277	0.289
	(0.436)	(0.442)	(0.446)	(0.449)	(1.104)	(1.110)	(1.111)	(1.112)
1(Noncontiguous state)	-1.673	-1.672	-1.669	-1.656	-1.025	-1.017	-1.025	-1.053
	(1.275)	(1.276)	(1.276)	(1.276)	(1.510)	(1.516)	(1.516)	(1.517)
1(Oil producer)	0.727	0.727	0.730	0.762	0.622	0.617	0.628	0.660
	(0.730)	(0.730)	(0.731)	(0.725)	(0.785)	(0.787)	(0.788)	(0.781)
1(New State)	1.651***	1.650***	1.649***	1.643***	1.501***	1.503***	1.499***	1.490***
	(0.424)	(0.424)	(0.424)	(0.423)	(0.515)	(0.516)	(0.516)	(0.516)
1(Instability)	0.587**	0.587**	0.588**	0.589**	0.583**	0.583**	0.583**	0.581**
	(0.280)	(0.280)	(0.280)	(0.280)	(0.289)	(0.289)	(0.289)	(0.289)
1(PolityIV)	-0.00163	-0.00165	-0.00161	-0.00134	0.00401	0.00391	0.00419	0.00508
	(0.0265)	(0.0265)	(0.0265)	(0.0265)	(0.0296)	(0.0296)	(0.0296)	(0.0296)
1(Anocracy)	0.661**	0.662**	0.663**	0.667**	0.673**	0.671**	0.674**	0.680**
	(0.278)	(0.279)	(0.279)	(0.278)	(0.287)	(0.287)	(0.288)	(0.288)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table B6. Determinants of Civil War Onset Controling for Frequency of Storm Events, 1945-1999 (n=2736)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Storm_t$	-0.0432	-0.0841	-0.147	-0.0382	-0.0646	-0.0999	-0.175	-0.0140
	(0.145)	(0.164)	(0.179)	(0.194)	(0.153)	(0.170)	(0.189)	(0.198)
$Storm_{t-1}$	--	0.0823	0.00322	0.0420	--	0.0729	-0.00864	0.0439
		(0.148)	(0.160)	(0.160)		(0.146)	(0.160)	(0.161)
$Storm_{t-2}$	--	--	0.217	**0.276***	--	--	0.212	**0.317***
			(0.157)	(0.165)			(0.166)	(0.179)
$Storm_{t-3}$	--	--	--	-0.332	--	--	--	**-0.511***
				(0.246)				(0.278)
Prior war	-2.342***	-2.355***	-2.381***	-2.359***	-2.361***	-2.370***	-2.387***	-2.392***
	(0.390)	(0.392)	(0.394)	(0.392)	(0.403)	(0.404)	(0.406)	(0.406)
GDP/capita, lagged	-0.122	-0.124	-0.127	-0.126	-0.227	-0.226	-0.230	-0.242
	(0.155)	(0.155)	(0.155)	(0.155)	(0.194)	(0.194)	(0.195)	(0.195)
log(Population Density)	1.236***	1.218***	1.183***	1.220***	0.297	0.311	0.292	0.218
	(0.425)	(0.426)	(0.427)	(0.429)	(1.094)	(1.095)	(1.095)	(1.101)
1(Noncontiguous state)	-1.662	-1.660	-1.654	-1.613	-1.017	-1.040	-1.040	-0.961
	(1.274)	(1.274)	(1.274)	(1.274)	(1.510)	(1.512)	(1.513)	(1.510)
1(Oil producer)	0.720	0.727	0.737	0.729	0.610	0.618	0.631	0.612
	(0.727)	(0.728)	(0.729)	(0.726)	(0.782)	(0.783)	(0.784)	(0.781)
1(New State)	1.647***	1.649***	1.646***	1.661***	1.490***	1.493***	1.494***	1.528***
	(0.423)	(0.423)	(0.423)	(0.423)	(0.513)	(0.512)	(0.512)	(0.513)
1(Instability)	0.587**	0.588**	0.589**	0.584**	0.585**	0.583**	0.581**	0.571**
	(0.280)	(0.280)	(0.280)	(0.280)	(0.289)	(0.289)	(0.289)	(0.289)
1(PolityIV)	-0.00205	-0.00206	-0.00245	-0.00128	0.00419	0.00466	0.00420	0.00645
	(0.0264)	(0.0264)	(0.0264)	(0.0265)	(0.0296)	(0.0296)	(0.0296)	(0.0298)
1(Anocracy)	0.660**	0.662**	0.674**	0.652**	0.671**	0.673**	0.682**	0.648**
	(0.278)	(0.278)	(0.278)	(0.279)	(0.287)	(0.287)	(0.287)	(0.289)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table B7. Determinants of Civil War Onset Controling for Frequency of Wildfire Events, 1945-1999 (n=2736)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Wildfire_t$	**1.001****	**1.023****	**0.949***	**0.989***	**1.062***	**1.068***	**1.034***	**1.029***
	(0.496)	(0.517)	(0.545)	(0.545)	(0.569)	(0.574)	(0.584)	(0.591)
$Wildfire_{t-1}$	--	-0.110	-0.244	-0.237	--	-0.0593	-0.180	-0.180
		(0.771)	(0.828)	(0.812)		(0.806)	(0.842)	(0.843)
$Wildfire_{t-2}$	--	--	0.425	0.509	--	--	0.591	0.582
			(0.698)	(0.705)			(0.731)	(0.745)
$Wildfire_{t-3}$	--	--	--	-0.550	--	--	--	0.0786
				(1.233)				(1.185)
Prior war	-2.385***	-2.384***	-2.384***	-2.381***	-2.375***	-2.375***	-2.366***	-2.366***
	(0.392)	(0.392)	(0.392)	(0.392)	(0.404)	(0.404)	(0.405)	(0.405)
GDP/capita, lagged	-0.139	-0.139	-0.139	-0.138	-0.205	-0.207	-0.189	-0.189
	(0.157)	(0.157)	(0.157)	(0.157)	(0.194)	(0.196)	(0.197)	(0.197)
log(Population Density)	1.187***	1.187***	1.186***	1.186***	0.756	0.734	0.929	0.934
	(0.423)	(0.423)	(0.424)	(0.423)	(1.132)	(1.170)	(1.206)	(1.209)
1(Noncontiguous state)	-1.655	-1.655	-1.650	-1.650	-1.366	-1.346	-1.486	-1.492
	(1.274)	(1.274)	(1.274)	(1.274)	(1.525)	(1.538)	(1.552)	(1.553)
1(Oil producer)	0.704	0.706	0.687	0.685	0.626	0.626	0.626	0.629
	(0.719)	(0.720)	(0.722)	(0.722)	(0.772)	(0.773)	(0.771)	(0.772)
1(New State)	1.658***	1.657***	1.661***	1.659***	1.438***	1.441***	1.418***	1.417***
	(0.422)	(0.422)	(0.422)	(0.422)	(0.514)	(0.515)	(0.516)	(0.517)
1(Instability)	0.609**	0.608**	0.613**	0.608**	0.592**	0.592**	0.597**	0.597**
	(0.279)	(0.280)	(0.280)	(0.280)	(0.289)	(0.289)	(0.289)	(0.290)
1(PolityIV)	-0.00887	-0.00857	-0.00907	-0.00873	0.00255	0.00261	0.00254	0.00255
	(0.0268)	(0.0269)	(0.0269)	(0.0269)	(0.0297)	(0.0298)	(0.0298)	(0.0298)
1(Anocracy)	0.656**	0.657**	0.646**	0.646**	0.678**	0.678**	0.672**	0.672**
	(0.278)	(0.278)	(0.279)	(0.279)	(0.287)	(0.287)	(0.288)	(0.288)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table B8. Determinants of Civil War Onset Controling for Frequency of All Disaster Events, 1945-1999 (n=2736)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
Drought_t	-0.0932	-0.0561	-0.0536	-0.114	-0.226	-0.194	-0.148	-0.242
	(0.368)	(0.383)	(0.385)	(0.397)	(0.396)	(0.414)	(0.413)	(0.426)
Drought_{t-1}	--	0.134	0.389	0.425	--	0.112	0.336	0.323
		(0.367)	(0.382)	(0.382)		(0.388)	(0.408)	(0.413)
Drought_{t-2}	--	--	**-0.919***	**-0.874***	--	--	**-0.908***	-0.876
			(0.502)	(0.520)			(0.527)	(0.555)
Drought_{t-3}	--	--	--	0.0182	--	--	--	0.113
				(0.438)				(0.458)
Extreme Cold_t	**0.975***	0.727	0.559	0.852	**1.045***	0.843	0.696	1.011
	(0.521)	(0.577)	(0.627)	(0.636)	(0.553)	(0.618)	(0.652)	(0.654)
$\text{Extreme Cold}_{t-1}$	--	0.674	0.503	0.386	--	0.670	0.636	0.662
		(0.665)	(0.724)	(0.852)		(0.654)	(0.713)	(0.841)
$\text{Extreme Cold}_{t-2}$	--	--	0.442	0.241	--	--	0.134	-0.413
			(0.772)	(0.985)			(0.776)	(1.057)
$\text{Extreme Cold}_{t-3}$	--	--	--	-0.135	--	--	--	-0.0567
				(1.143)				(1.164)
Extreme Heat_t	-14.75	-14.59	-13.88	-15.04	-16.65	-17.10	-16.73	-16.03
	(1,156)	(813.2)	(595.4)	(891.8)	(3,166)	(3,891)	(3,438)	(2,732)
$\text{Extreme Heat}_{t-1}$	--	1.061	0.982	**1.416***	--	1.025	0.934	**1.582***
		(0.750)	(0.750)	(0.744)		(0.884)	(0.889)	(0.869)
$\text{Extreme Heat}_{t-2}$	--	--	0.847	0.824	--	--	0.711	0.615
			(0.827)	(0.903)			(0.866)	(0.939)
$\text{Extreme Heat}_{t-3}$	--	--	--	0.972	--	--	--	1.291
				(0.934)				(0.996)
Epidemic_t	0.258	0.250	0.234	0.228	0.301	0.292	0.301	0.318
	(0.187)	(0.191)	(0.195)	(0.202)	(0.205)	(0.212)	(0.218)	(0.227)
Epidemic_{t-1}	--	0.128	0.176	0.270	--	0.0590	0.104	0.171
		(0.233)	(0.243)	(0.250)		(0.276)	(0.285)	(0.287)
Epidemic_{t-2}	--	--	-0.0900	-0.154	--	--	-0.0231	-0.0606
			(0.321)	(0.344)			(0.337)	(0.365)
Epidemic_{t-3}	--	--	--	-0.344	--	--	--	-0.374
				(0.383)				(0.415)
Flood_t	-0.0682	-0.0726	-0.0626	-0.113	-0.0473	-0.0613	-0.0454	-0.114
	(0.145)	(0.160)	(0.163)	(0.165)	(0.150)	(0.166)	(0.172)	(0.180)
Flood_{t-1}	--	-0.0966	-0.146	-0.0451	--	-0.0837	-0.136	0.00322
		(0.169)	(0.175)	(0.185)		(0.176)	(0.183)	(0.198)
Flood_{t-2}	--	--	-0.0332	-0.0583	--	--	0.00895	-0.0291
			(0.176)	(0.180)			(0.191)	(0.194)
Flood_{t-3}	--	--	--	0.0878	--	--	--	0.144
				(0.182)				(0.190)
Storm_t	-0.0830	-0.164	-0.222	-0.0257	-0.0666	-0.130	-0.219	0.00885
	(0.160)	(0.190)	(0.209)	(0.223)	(0.164)	(0.193)	(0.217)	(0.222)
Storm_{t-1}	--	0.103	0.0214	0.00576	--	0.0959	-9.44e-05	-0.0178
		(0.159)	(0.169)	(0.181)		(0.159)	(0.173)	(0.190)
Storm_{t-2}	--	--	0.265	**0.369****	--	--	0.273	**0.434****
			(0.167)	(0.181)			(0.174)	(0.198)
Storm_{t-3}	--	--	--	**-0.517***	--	--	--	**-0.732****
				(0.273)				(0.320)
Wildfire_t	0.686	0.784	0.897	0.985	0.757	0.872	0.980	1.026
	(0.568)	(0.591)	(0.604)	(0.616)	(0.598)	(0.617)	(0.634)	(0.655)
Wildfire_{t-1}	--	-0.379	-0.447	-0.458	--	-0.250	-0.337	-0.189
		(0.894)	(0.971)	(1.013)		(0.895)	(0.946)	(0.986)
Wildfire_{t-2}	--	--	0.248	0.240	--	--	0.426	0.189
			(0.829)	(0.860)			(0.851)	(0.911)
Wildfire_{t-3}	--	--	--	-1.098	--	--	--	-0.325
				(1.841)				(1.688)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models that include the full set of control variables (same as in Tables). Standard errors in parentheses. Control variable estimates are not displayed. *** p<0.01, ** p<0.05, * p<0.1.

Table B9. Determinants of Civil War Onset : Significant Coefficients from Individual Event Conditional (Fixed Effects) Logit Models, 1945-1999 (n=2736)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
$Drought_{t-2}$	-0.829* to -0.861*	O3,O4	--	--
Extreme $Cold_t$	1.016** to 1.127**	O1,O2,O3,O4	1.128** to 1.183**	O5,O6,O7,O8
Extreme $Heat_{t-1}$	1.118* to 1.216*	O2,O4	--	--
$Storm_{t-2}$	0.276*	O4	0.317*	O8
$Storm_{t-3}$	--	--	-0.511*	O8
$Wildfire_t$	0.949* to 1.023**	O1,O2,O3,O4	1.029* to 1.068*	O5,O6,O7,O8
Control Variables	Yes		Yes	
Country Fixed Effects	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix B Tables B1 through B7. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table B10. Determinants of Civil War Onset : Significant Coefficients from All Events Conditional (Fixed Effects) Logit Models, 1945-1999 (n=2736)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
$Drought_{t-2}$	-0.874* to -0.919*	O3,O4	-0.908*	O7
Extreme $Cold_t$	0.975*	O1	1.045*	O5
Extreme $Heat_{t-1}$	1.416*	O4	1.582*	O8
$Storm_{t-2}$	0.369**	O4	0.434**	O8
$Storm_{t-3}$	-0.517*	O4	-0.732**	O8
Control Variables	Yes		Yes	
Country Fixed Effects	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix B Table B8. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

C. Civil War Onset Estimated With Fixed Effects

Linear Probability Model

In appendix C I estimate equations (1) and (2) using the fixed effects linear probability econometric method. I also expand equations (1) by adding up to three lags of a given climate change related disaster event, as well as time fixed effects. Table C0 below relates estimated models to econometric specifications in the paper. Tables C1 through C7 provide estimates of models O1 through O8 for each disaster event. Table C8 provides estimates of models O1 through O8 for all disaster events jointly. Table C1 provides estimates for drought events; C2 for extreme cold temperature events; C3 for extreme heat events; C4 for epidemic outbreaks; C5 for flood events; C6 for storm events; and C7 for wildfire events.

Table C0. Description of Appendix C Tables

Model	Lags on a disaster variable	Equivalence to equations in the paper
O1	0	Equation (1)
O2	1	Equation (1)+$Disaster_{t-1}$
O3	2	Equation (1)+$Disaster_{t-1}$+ $Disaster_{t-2}$
O4	3	Equation (1)+$Disaster_{t-1}$+ $Disaster_{t-2}$+ $Disaster_{t-3}$
O5	0	Equation (2)-$Disaster_{t-1}$-$Disaster_{t-2}$-$Disaster_{t-3}$
O6	1	Equation (2)-$Disaster_{t-2}$-$Disaster_{t-3}$
O7	2	Equation (2)-$Disaster_{t-3}$
O8	3	Equation (2)

Table C1. Determinants of Civil War Onset Controling for Frequency of Drought Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Drought_t$	-0.00355	-0.00447	-0.00393	-0.00395	-0.00584	-0.00628	-0.00576	-0.00580
	(0.00593)	(0.00622)	(0.00622)	(0.00622)	(0.00604)	(0.00632)	(0.00633)	(0.00633)
$Drought_{t-1}$	--	0.00311	0.00694	0.00692	--	0.00152	0.00481	0.00476
		(0.00634)	(0.00663)	(0.00663)		(0.00646)	(0.00673)	(0.00674)
$Drought_{t-2}$	--	--	**-0.0129****	**-0.0131***	--	--	**-0.0114***	**-0.0118***
			(0.00647)	(0.00676)			(0.00659)	(0.00687)
$Drought_{t-3}$	--	--	--	0.000776	--	--	--	0.00129
				(0.00660)				(0.00673)
Prior war	-0.0725***	-0.0725***	-0.0722***	-0.0722***	-0.0731***	-0.0732***	-0.0730***	-0.0730***
	(0.00675)	(0.00675)	(0.00675)	(0.00675)	(0.00680)	(0.00680)	(0.00680)	(0.00680)
GDP/capita, lagged	-0.000526	-0.000531	-0.000509	-0.000510	-0.00131	-0.00131	-0.00134	-0.00134
	(0.000829)	(0.000829)	(0.000829)	(0.000829)	(0.00114)	(0.00114)	(0.00114)	(0.00114)
log(Population Density)	0.0183***	0.0181***	0.0191***	0.0190***	0.00466	0.00466	0.00468	0.00467
	(0.00601)	(0.00603)	(0.00605)	(0.00607)	(0.0129)	(0.0129)	(0.0129)	(0.0129)
log(% mountains)	0.00942	0.00942	0.00958	0.00957	0.0113	0.0112	0.0115	0.0115
	(0.0105)	(0.0105)	(0.0105)	(0.0105)	(0.0108)	(0.0108)	(0.0108)	(0.0108)
1(Noncontiguous state)	-0.0778**	-0.0779**	-0.0775**	-0.0775**	-0.0650*	-0.0651*	-0.0641*	-0.0642*
	(0.0349)	(0.0349)	(0.0349)	(0.0349)	(0.0359)	(0.0359)	(0.0359)	(0.0359)
1(Oil producer)	0.0129	0.0129	0.0129	0.0129	0.0106	0.0106	0.0104	0.0105
	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0104)	(0.0104)	(0.0104)	(0.0104)
1(New State)	0.0634***	0.0635***	0.0631***	0.0631***	0.0617***	0.0618***	0.0616***	0.0616***
	(0.0108)	(0.0108)	(0.0108)	(0.0108)	(0.0112)	(0.0112)	(0.0112)	(0.0112)
1(Instability)	0.0131***	0.0131**	0.0132***	0.0132***	0.0121**	0.0121**	0.0121**	0.0121**
	(0.00509)	(0.00510)	(0.00509)	(0.00509)	(0.00513)	(0.00513)	(0.00513)	(0.00513)
1(PolityIV)	0.000292	0.000292	0.000301	0.000300	0.000328	0.000328	0.000340	0.000339
	(0.000422)	(0.000422)	(0.000422)	(0.000422)	(0.000447)	(0.000448)	(0.000448)	(0.000448)
1(Anocracy)	0.0171***	0.0172***	0.0170***	0.0170***	0.0167***	0.0167***	0.0166***	0.0166***
	(0.00492)	(0.00492)	(0.00492)	(0.00493)	(0.00497)	(0.00497)	(0.00497)	(0.00497)
Constant	0.122**	0.121**	0.124**	0.124**	0.0729	0.0731	0.0716	0.0717
	(0.0484)	(0.0485)	(0.0485)	(0.0485)	(0.0765)	(0.0765)	(0.0765)	(0.0765)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.062	0.062	0.063	0.063	0.070	0.070	0.071	0.071

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table C2. Determinants of Civil War Onset Controling for Frequency of Extreme Cold Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
Extreme Cold$_t$	**0.0408*** **	**0.0379*** **	**0.0374*** **	**0.0378*** **	**0.0401*** **	**0.0377*** **	**0.0372*** **	**0.0375*** **
	(0.0127)	(0.0129)	(0.0129)	(0.0129)	(0.0128)	(0.0130)	(0.0131)	(0.0131)
Extreme Cold$_{t-1}$	--	0.0160	0.0144	0.0147	--	0.0137	0.0124	0.0126
		(0.0133)	(0.0134)	(0.0134)		(0.0134)	(0.0135)	(0.0136)
Extreme Cold$_{t-2}$	--	--	0.0102	0.0118	--	--	0.00906	0.0105
			(0.0137)	(0.0138)			(0.0138)	(0.0139)
Extreme Cold$_{t-3}$	--	--	--	-0.0125	--	--	--	-0.0115
				(0.0149)				(0.0150)
Prior war	-0.0732***	-0.0734***	-0.0735***	-0.0735***	-0.0737***	-0.0738***	-0.0739***	-0.0739***
	(0.00674)	(0.00675)	(0.00675)	(0.00675)	(0.00680)	(0.00680)	(0.00680)	(0.00680)
GDP/capita, lagged	-0.000656	-0.000692	-0.000715	-0.000691	-0.00117	-0.00114	-0.00113	-0.00113
	(0.000829)	(0.000829)	(0.000830)	(0.000831)	(0.00114)	(0.00114)	(0.00114)	(0.00114)
log(Population Density)	0.0171***	0.0168***	0.0167***	0.0169***	0.00754	0.00823	0.00851	0.00831
	(0.00597)	(0.00598)	(0.00598)	(0.00598)	(0.0129)	(0.0130)	(0.0130)	(0.0130)
log(% mountains)	0.00794	0.00747	0.00717	0.00756	0.00904	0.00847	0.00813	0.00856
	(0.0105)	(0.0105)	(0.0105)	(0.0105)	(0.0108)	(0.0108)	(0.0108)	(0.0108)
1(Noncontiguous state)	-0.0766**	-0.0762**	-0.0760**	-0.0763**	-0.0668*	-0.0671*	-0.0672*	-0.0672*
	(0.0349)	(0.0349)	(0.0349)	(0.0349)	(0.0358)	(0.0358)	(0.0358)	(0.0358)
1(Oil producer)	0.0128	0.0127	0.0127	0.0126	0.0105	0.0104	0.0104	0.0104
	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0104)	(0.0104)	(0.0104)	(0.0104)
1(New State)	0.0637***	0.0637***	0.0637***	0.0637***	0.0620***	0.0620***	0.0620***	0.0620***
	(0.0108)	(0.0108)	(0.0108)	(0.0108)	(0.0112)	(0.0112)	(0.0112)	(0.0112)
1(Instability)	0.0134***	0.0135***	0.0136***	0.0136***	0.0123**	0.0124**	0.0125**	0.0124**
	(0.00509)	(0.00509)	(0.00509)	(0.00509)	(0.00512)	(0.00513)	(0.00513)	(0.00513)
1(PolityIV)	0.000202	0.000175	0.000165	0.000178	0.000273	0.000262	0.000260	0.000265
	(0.000423)	(0.000424)	(0.000424)	(0.000424)	(0.000447)	(0.000448)	(0.000448)	(0.000448)
1(Anocracy)	0.0170***	0.0169***	0.0169***	0.0169***	0.0166***	0.0166***	0.0166***	0.0166***
	(0.00491)	(0.00491)	(0.00491)	(0.00491)	(0.00496)	(0.00496)	(0.00496)	(0.00496)
Constant	0.118**	0.117**	0.117**	0.117**	0.0889	0.0926	0.0942	0.0930
	(0.0483)	(0.0483)	(0.0483)	(0.0483)	(0.0766)	(0.0767)	(0.0767)	(0.0767)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.064	0.064	0.064	0.064	0.072	0.072	0.072	0.072

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table C3. Determinants of Civil War Onset Controling for Frequency of Extreme Heat Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
Extreme Heat$_t$	**-0.0263***	**-0.0292***	**-0.0281***	**-0.0290***	-0.0246	**-0.0277***	**-0.0266***	**-0.0273***
	(0.0157)	(0.0158)	(0.0158)	(0.0158)	(0.0158)	(0.0159)	(0.0159)	(0.0159)
Extreme Heat$_{t-1}$	--	**0.0266***	0.0239	0.0254	--	**0.0284***	0.0256	**0.0271***
		(0.0161)	(0.0162)	(0.0162)		(0.0162)	(0.0163)	(0.0163)
Extreme Heat$_{t-2}$	--	--	0.0249	0.0210	--	--	0.0249	0.0212
			(0.0166)	(0.0168)			(0.0167)	(0.0169)
Extreme Heat$_{t-3}$	--	--	--	**0.0292***	--	--	--	0.0278
				(0.0169)				(0.0170)
Prior war	-0.0724***	-0.0725***	-0.0727***	-0.0729***	-0.0731***	-0.0732***	-0.0735***	-0.0736***
	(0.00675)	(0.00675)	(0.00675)	(0.00675)	(0.00680)	(0.00680)	(0.00680)	(0.00680)
GDP/capita, lagged	-0.000471	-0.000536	-0.000588	-0.000658	-0.00129	-0.00130	-0.00131	-0.00133
	(0.000830)	(0.000831)	(0.000831)	(0.000832)	(0.00114)	(0.00114)	(0.00114)	(0.00114)
log(Population Density)	0.0181***	0.0179***	0.0178***	0.0175***	0.00393	0.00462	0.00509	0.00563
	(0.00597)	(0.00597)	(0.00597)	(0.00597)	(0.0129)	(0.0129)	(0.0129)	(0.0129)
log(% mountains)	0.0117	0.00982	0.00809	0.00616	0.0134	0.0113	0.00941	0.00743
	(0.0106)	(0.0106)	(0.0107)	(0.0108)	(0.0109)	(0.0109)	(0.0110)	(0.0111)
1(Noncontiguous state)	-0.0823**	-0.0792**	-0.0760**	-0.0736**	-0.0691*	-0.0664*	-0.0636*	-0.0618*
	(0.0350)	(0.0350)	(0.0351)	(0.0351)	(0.0359)	(0.0360)	(0.0360)	(0.0360)
1(Oil producer)	0.0132	0.0131	0.0132	0.0136	0.0109	0.0109	0.0110	0.0112
	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0104)	(0.0104)	(0.0104)	(0.0104)
1(New State)	0.0636***	0.0635***	0.0635***	0.0634***	0.0623***	0.0621***	0.0619***	0.0618***
	(0.0108)	(0.0108)	(0.0108)	(0.0108)	(0.0112)	(0.0112)	(0.0112)	(0.0112)
1(Instability)	0.0132***	0.0132***	0.0134***	0.0134***	0.0121**	0.0121**	0.0123**	0.0123**
	(0.00509)	(0.00509)	(0.00509)	(0.00509)	(0.00513)	(0.00513)	(0.00513)	(0.00513)
1(PolityIV)	0.000306	0.000293	0.000278	0.000269	0.000325	0.000323	0.000315	0.000317
	(0.000422)	(0.000422)	(0.000423)	(0.000422)	(0.000447)	(0.000447)	(0.000447)	(0.000447)
1(Anocracy)	0.0173***	0.0173***	0.0173***	0.0173***	0.0169***	0.0169***	0.0169***	0.0169***
	(0.00492)	(0.00492)	(0.00492)	(0.00491)	(0.00497)	(0.00496)	(0.00496)	(0.00496)
Constant	0.124**	0.122**	0.119**	0.116**	0.0728	0.0742	0.0745	0.0760
	(0.0484)	(0.0484)	(0.0485)	(0.0485)	(0.0765)	(0.0765)	(0.0765)	(0.0765)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.062	0.063	0.063	0.064	0.071	0.071	0.071	0.072

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table C4. Determinants of Civil War Onset Controling for Frequency Epidemic Outbreaks, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Epidemic_t$	**0.00757***	0.00708	0.00720	0.00730	**0.00806***	**0.00785***	**0.00793***	**0.00804***
	(0.00443)	(0.00456)	(0.00458)	(0.00459)	(0.00461)	(0.00471)	(0.00472)	(0.00473)
$Epidemic_{t-1}$	--	0.00222	0.00250	0.00266	--	0.00110	0.00128	0.00144
		(0.00502)	(0.00511)	(0.00512)		(0.00515)	(0.00523)	(0.00524)
$Epidemic_{t-2}$	--	--	-0.00159	-0.00108	--	--	-0.00116	-0.000729
			(0.00557)	(0.00562)			(0.00570)	(0.00575)
$Epidemic_{t-3}$	--	--	--	-0.00383	--	--	--	-0.00380
				(0.00603)				(0.00616)
Prior war	-0.0729***	-0.0730***	-0.0729***	-0.0728***	-0.0737***	-0.0737***	-0.0737***	-0.0736***
	(0.00675)	(0.00675)	(0.00675)	(0.00675)	(0.00680)	(0.00681)	(0.00681)	(0.00681)
GDP/capita, lagged	-0.000489	-0.000479	-0.000483	-0.000494	-0.00120	-0.00119	-0.00120	-0.00123
	(0.000829)	(0.000830)	(0.000830)	(0.000830)	(0.00115)	(0.00115)	(0.00115)	(0.00115)
log(Population Density)	0.0157**	0.0152**	0.0155**	0.0160**	0.00303	0.00286	0.00296	0.00322
	(0.00611)	(0.00619)	(0.00625)	(0.00630)	(0.0129)	(0.0130)	(0.0130)	(0.0130)
log(% mountains)	0.00872	0.00859	0.00866	0.00883	0.0103	0.0103	0.0103	0.0105
	(0.0105)	(0.0105)	(0.0105)	(0.0105)	(0.0108)	(0.0108)	(0.0108)	(0.0108)
1(Noncontiguous state)	-0.0777**	-0.0777**	-0.0777**	-0.0776**	-0.0658*	-0.0658*	-0.0657*	-0.0654*
	(0.0349)	(0.0349)	(0.0349)	(0.0349)	(0.0358)	(0.0358)	(0.0359)	(0.0359)
1(Oil producer)	0.0132	0.0133	0.0132	0.0131	0.0107	0.0107	0.0107	0.0106
	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0104)	(0.0104)	(0.0104)	(0.0104)
1(New State)	0.0640***	0.0640***	0.0640***	0.0640***	0.0622***	0.0623***	0.0623***	0.0623***
	(0.0108)	(0.0108)	(0.0108)	(0.0108)	(0.0112)	(0.0112)	(0.0112)	(0.0112)
1(Instability)	0.0132***	0.0132***	0.0132***	0.0132***	0.0120**	0.0120**	0.0120**	0.0119**
	(0.00509)	(0.00510)	(0.00510)	(0.00510)	(0.00513)	(0.00513)	(0.00513)	(0.00513)
1(PolityIV)	0.000269	0.000265	0.000265	0.000265	0.000340	0.000340	0.000338	0.000332
	(0.000423)	(0.000423)	(0.000423)	(0.000423)	(0.000447)	(0.000448)	(0.000448)	(0.000448)
1(Anocracy)	0.0168***	0.0167***	0.0168***	0.0168***	0.0166***	0.0166***	0.0166***	0.0166***
	(0.00492)	(0.00493)	(0.00493)	(0.00493)	(0.00497)	(0.00497)	(0.00497)	(0.00497)
Constant	0.113**	0.112**	0.112**	0.114**	0.0683	0.0678	0.0680	0.0685
	(0.0485)	(0.0486)	(0.0487)	(0.0488)	(0.0765)	(0.0766)	(0.0766)	(0.0766)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.062	0.062	0.062	0.063	0.071	0.071	0.071	0.071

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table C5. Determinant of Civil War Onset Controling for Frequency of Flood Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Flood_t$	-0.00202	-0.00175	-0.00161	-0.00173	-0.00199	-0.00163	-0.00153	-0.00164
	(0.00254)	(0.00261)	(0.00264)	(0.00267)	(0.00258)	(0.00264)	(0.00267)	(0.00270)
$Flood_{t-1}$	--	-0.00114	-0.000936	-0.00106	--	-0.00167	-0.00152	-0.00164
		(0.00271)	(0.00277)	(0.00280)		(0.00274)	(0.00280)	(0.00283)
$Flood_{t-2}$	--	--	-0.000952	-0.00112	--	--	-0.000689	-0.000845
			(0.00284)	(0.00289)			(0.00287)	(0.00292)
$Flood_{t-3}$	--	--	--	0.000901	--	--	--	0.000901
				(0.00295)				(0.00298)
Prior war	-0.0722***	-0.0721***	-0.0720***	-0.0720***	-0.0730***	-0.0728***	-0.0727***	-0.0728***
	(0.00676)	(0.00677)	(0.00678)	(0.00678)	(0.00681)	(0.00682)	(0.00682)	(0.00683)
GDP/capita, lagged	-0.000493	-0.000470	-0.000458	-0.000465	-0.00132	-0.00132	-0.00133	-0.00132
	(0.000831)	(0.000833)	(0.000834)	(0.000834)	(0.00114)	(0.00114)	(0.00114)	(0.00115)
log(Population Density)	0.0190***	0.0194***	0.0197***	0.0195***	0.00462	0.00458	0.00457	0.00457
	(0.00612)	(0.00620)	(0.00626)	(0.00630)	(0.0129)	(0.0129)	(0.0129)	(0.0129)
log(% mountains)	0.0105	0.0110	0.0112	0.0110	0.0124	0.0132	0.0134	0.0132
	(0.0106)	(0.0106)	(0.0107)	(0.0107)	(0.0109)	(0.0110)	(0.0110)	(0.0110)
1(Noncontiguous state)	-0.0787**	-0.0791**	-0.0793**	-0.0791**	-0.0657*	-0.0658*	-0.0658*	-0.0658*
	(0.0349)	(0.0349)	(0.0349)	(0.0349)	(0.0359)	(0.0359)	(0.0359)	(0.0359)
1(Oil producer)	0.0129	0.0128	0.0127	0.0127	0.0107	0.0106	0.0105	0.0106
	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0104)	(0.0104)	(0.0104)	(0.0104)
1(New State)	0.0637***	0.0637***	0.0637***	0.0637***	0.0623***	0.0624***	0.0624***	0.0624***
	(0.0108)	(0.0108)	(0.0108)	(0.0108)	(0.0112)	(0.0112)	(0.0112)	(0.0112)
1(Instability)	0.0131**	0.0131***	0.0131**	0.0131**	0.0121**	0.0121**	0.0121**	0.0121**
	(0.00509)	(0.00510)	(0.00510)	(0.00510)	(0.00513)	(0.00513)	(0.00513)	(0.00513)
1(PolityIV)	0.000306	0.000309	0.000312	0.000311	0.000323	0.000319	0.000318	0.000320
	(0.000423)	(0.000423)	(0.000423)	(0.000423)	(0.000447)	(0.000448)	(0.000448)	(0.000448)
1(Anocracy)	0.0171***	0.0170***	0.0170***	0.0170***	0.0167***	0.0166***	0.0165***	0.0166***
	(0.00492)	(0.00493)	(0.00493)	(0.00493)	(0.00497)	(0.00498)	(0.00498)	(0.00498)
Constant	0.124**	0.126***	0.127***	0.126**	0.0725	0.0718	0.0715	0.0718
	(0.0486)	(0.0488)	(0.0489)	(0.0489)	(0.0765)	(0.0765)	(0.0765)	(0.0765)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.062	0.062	0.062	0.062	0.070	0.070	0.070	0.070

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table C6. Determinants of Civil War Onset Controling for Frequency of Storm Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Storm_t$	-0.000902	-0.00127	-0.00185	-0.000987	-0.00103	-0.00124	-0.00181	-0.000932
	(0.00189)	(0.00225)	(0.00231)	(0.00239)	(0.00191)	(0.00226)	(0.00233)	(0.00240)
$Storm_{t-1}$	--	0.000699	-0.000350	0.000102	--	0.000407	-0.000637	-0.000181
		(0.00229)	(0.00248)	(0.00250)		(0.00230)	(0.00250)	(0.00252)
$Storm_{t-2}$	--	--	0.00261	0.00378	--	--	0.00259	0.00380
			(0.00240)	(0.00254)			(0.00242)	(0.00256)
$Storm_{t-3}$	--	--	--	-0.00367	--	--	--	-0.00376
				(0.00255)				(0.00257)
Prior war	-0.0725***	-0.0725***	-0.0726***	-0.0725***	-0.0732***	-0.0732***	-0.0733***	-0.0732***
	(0.00675)	(0.00675)	(0.00675)	(0.00675)	(0.00680)	(0.00681)	(0.00681)	(0.00681)
GDP/capita, lagged	-0.000474	-0.000496	-0.000554	-0.000490	-0.00124	-0.00125	-0.00129	-0.00126
	(0.000840)	(0.000844)	(0.000845)	(0.000846)	(0.00115)	(0.00115)	(0.00115)	(0.00115)
log(GDP/capita, lagged)	0.0182***	0.0181***	0.0178***	0.0182***	0.00452	0.00452	0.00459	0.00446
	(0.00600)	(0.00601)	(0.00602)	(0.00602)	(0.0129)	(0.0129)	(0.0129)	(0.0129)
log(Population Density)	0.0110	0.0105	0.00917	0.0103	0.0130	0.0127	0.0113	0.0126
	(0.0110)	(0.0111)	(0.0112)	(0.0112)	(0.0113)	(0.0114)	(0.0115)	(0.0115)
1(Noncontiguous state)	-0.0780**	-0.0780**	-0.0780**	-0.0776**	-0.0654*	-0.0654*	-0.0656*	-0.0650*
	(0.0349)	(0.0349)	(0.0349)	(0.0349)	(0.0359)	(0.0359)	(0.0359)	(0.0359)
1(Oil producer)	0.0128	0.0129	0.0129	0.0128	0.0106	0.0106	0.0107	0.0105
	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0104)	(0.0104)	(0.0104)	(0.0104)
1(New State)	0.0636***	0.0636***	0.0636***	0.0636***	0.0621***	0.0621***	0.0621***	0.0623***
	(0.0108)	(0.0108)	(0.0108)	(0.0108)	(0.0112)	(0.0112)	(0.0112)	(0.0112)
1(Instability)	0.0132***	0.0132***	0.0132***	0.0132***	0.0121**	0.0121**	0.0121**	0.0121**
	(0.00510)	(0.00510)	(0.00510)	(0.00510)	(0.00513)	(0.00513)	(0.00513)	(0.00513)
1(PolityIV)	0.000292	0.000291	0.000288	0.000286	0.000319	0.000319	0.000324	0.000308
	(0.000422)	(0.000422)	(0.000422)	(0.000422)	(0.000448)	(0.000448)	(0.000448)	(0.000448)
1(Anocracy)	0.0172***	0.0172***	0.0173***	0.0172***	0.0168***	0.0168***	0.0169***	0.0168***
	(0.00492)	(0.00492)	(0.00492)	(0.00492)	(0.00497)	(0.00497)	(0.00497)	(0.00497)
Constant	0.121**	0.121**	0.120**	0.121**	0.0726	0.0727	0.0735	0.0720
	(0.0484)	(0.0484)	(0.0484)	(0.0484)	(0.0765)	(0.0765)	(0.0765)	(0.0765)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.062	0.062	0.062	0.063	0.070	0.070	0.071	0.071

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table C7. Determinants of Civil War Onset Controling for Frequency of Wildfire Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Wildfire_t$	0.0143	0.0147	0.0135	0.0139	0.0147	0.0148	0.0137	0.0140
	(0.00909)	(0.00929)	(0.00946)	(0.00953)	(0.00921)	(0.00940)	(0.00956)	(0.00963)
$Wildfire_{t-1}$	--	-0.00208	-0.00282	-0.00239	--	-0.000938	-0.00170	-0.00135
		(0.00983)	(0.00990)	(0.00997)		(0.00992)	(0.00999)	(0.0101)
$Wildfire_{t-2}$	--	--	0.00698	0.00725	--	--	0.00735	0.00756
			(0.0107)	(0.0108)			(0.0108)	(0.0109)
$Wildfire_{t-3}$	--	--	--	-0.00398	--	--	--	-0.00323
				(0.0114)				(0.0115)
Prior war	-0.0726***	-0.0726***	-0.0726***	-0.0726***	-0.0732***	-0.0732***	-0.0732***	-0.0732***
	(0.00675)	(0.00675)	(0.00675)	(0.00675)	(0.00680)	(0.00680)	(0.00680)	(0.00680)
GDP/capita, lagged	-0.000711	-0.000694	-0.000738	-0.000717	-0.00139	-0.00138	-0.00141	-0.00140
	(0.000836)	(0.000840)	(0.000842)	(0.000845)	(0.00115)	(0.00115)	(0.00115)	(0.00115)
log(GDP/capita, lagged)	0.0174***	0.0174***	0.0173***	0.0174***	0.00540	0.00537	0.00557	0.00551
	(0.00598)	(0.00599)	(0.00599)	(0.00599)	(0.0129)	(0.0129)	(0.0129)	(0.0129)
log(Population Density)	0.00797	0.00812	0.00781	0.00795	0.00943	0.00950	0.00912	0.00925
	(0.0105)	(0.0106)	(0.0106)	(0.0106)	(0.0108)	(0.0108)	(0.0109)	(0.0109)
1(Noncontiguous state)	-0.0780**	-0.0779**	-0.0780**	-0.0779**	-0.0665*	-0.0665*	-0.0667*	-0.0666*
	(0.0349)	(0.0349)	(0.0349)	(0.0349)	(0.0359)	(0.0359)	(0.0359)	(0.0359)
1(Oil producer)	0.0132	0.0131	0.0132	0.0132	0.0109	0.0109	0.0110	0.0109
	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0104)	(0.0104)	(0.0104)	(0.0104)
1(New State)	0.0635***	0.0635***	0.0635***	0.0635***	0.0618***	0.0618***	0.0618***	0.0618***
	(0.0108)	(0.0108)	(0.0108)	(0.0108)	(0.0112)	(0.0112)	(0.0112)	(0.0112)
1(Instability)	0.0132***	0.0132***	0.0133***	0.0132***	0.0121**	0.0121**	0.0121**	0.0121**
	(0.00509)	(0.00509)	(0.00510)	(0.00510)	(0.00513)	(0.00513)	(0.00513)	(0.00513)
1(PolityIV)	0.000249	0.000253	0.000244	0.000250	0.000302	0.000303	0.000298	0.000301
	(0.000423)	(0.000424)	(0.000424)	(0.000424)	(0.000448)	(0.000448)	(0.000448)	(0.000448)
1(Anocracy)	0.0173***	0.0173***	0.0173***	0.0173***	0.0170***	0.0170***	0.0169***	0.0169***
	(0.00492)	(0.00492)	(0.00492)	(0.00492)	(0.00497)	(0.00497)	(0.00497)	(0.00497)
Constant	0.120**	0.120**	0.120**	0.120**	0.0793	0.0791	0.0806	0.0801
	(0.0484)	(0.0484)	(0.0484)	(0.0484)	(0.0766)	(0.0766)	(0.0766)	(0.0767)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.062	0.062	0.062	0.062	0.071	0.071	0.071	0.071

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table C8. Determinants of Civil War Onset Controling for Frequency of All Disaster Events, 1945-1999 (n=6278)

Variables	O1	O2	O3	O4	O5	O6	O7	O8
$Drought_{t}$	-0.00388	-0.00451	-0.00414	-0.00407	-0.00609	-0.00625	-0.00592	-0.00576
	(0.00594)	(0.00623)	(0.00625)	(0.00626)	(0.00606)	(0.00634)	(0.00635)	(0.00636)
$Drought_{t-1}$	--	0.00250	0.00662	0.00672	--	0.000749	0.00432	0.00446
		(0.00636)	(0.00665)	(0.00667)		(0.00648)	(0.00676)	(0.00677)
$Drought_{t-2}$	--	--	**-0.0132****	**-0.0131***	--	--	**-0.0120***	**-0.0120***
			(0.00651)	(0.00680)			(0.00663)	(0.00691)
$Drought_{t-3}$	--	--	--	-0.000899	--	--	--	-0.000714
				(0.00666)				(0.00679)
Extreme $Cold_{t}$	**0.0415*****	**0.0392*****	**0.0373*****	**0.0366*****	**0.0409*****	**0.0391*****	**0.0371*****	**0.0364*****
	(0.0127)	(0.0130)	(0.0131)	(0.0132)	(0.0129)	(0.0131)	(0.0133)	(0.0133)
Extreme $Cold_{t-1}$	--	0.0149	0.0123	0.0115	--	0.0125	0.00995	0.00919
		(0.0135)	(0.0136)	(0.0137)		(0.0136)	(0.0137)	(0.0138)
Extreme $Cold_{t-2}$	--	--	0.0140	0.0169	--	--	0.0128	0.0156
			(0.0140)	(0.0141)			(0.0141)	(0.0142)
Extreme $Cold_{t-3}$	--	--	--	-0.00820	--	--	--	-0.00757
				(0.0152)				(0.0153)
Extreme $Heat_{t}$	**-0.0297***	**-0.0315****	**-0.0285***	**-0.0280***	**-0.0277***	**-0.0296***	**-0.0271***	**-0.0269***
	(0.0158)	(0.0160)	(0.0162)	(0.0162)	(0.0159)	(0.0161)	(0.0163)	(0.0163)
Extreme $Heat_{t-1}$	--	0.0244	0.0215	0.0243	--	**0.0269***	0.0239	0.0266
		(0.0162)	(0.0164)	(0.0166)		(0.0163)	(0.0165)	(0.0167)
Extreme $Heat_{t-2}$	--	--	0.0236	0.0227	--	--	0.0244	0.0236
			(0.0170)	(0.0173)			(0.0171)	(0.0174)
Extreme $Heat_{t-3}$	--	--	--	0.0252	--	--	--	0.0249
				(0.0174)				(0.0175)
$Epidemic_{t}$	0.00729	0.00686	0.00695	0.00698	**0.00789***	**0.00781***	**0.00806***	**0.00817***
	(0.00446)	(0.00460)	(0.00461)	(0.00462)	(0.00463)	(0.00473)	(0.00475)	(0.00476)
$Epidemic_{t-1}$	--	0.00206	0.00293	0.00291	--	0.000983	0.00185	0.00196
		(0.00505)	(0.00514)	(0.00515)		(0.00518)	(0.00526)	(0.00526)
$Epidemic_{t-2}$	--	--	-0.00369	-0.00291	--	--	-0.00328	-0.00258
			(0.00562)	(0.00567)			(0.00575)	(0.00580)
$Epidemic_{t-3}$	--	--	--	-0.00534	--	--	--	-0.00548
				(0.00612)				(0.00625)
$Flood_{t}$	-0.00248	-0.00262	-0.00277	-0.00234	-0.00221	-0.00217	-0.00234	-0.00194
	(0.00265)	(0.00272)	(0.00275)	(0.00278)	(0.00268)	(0.00275)	(0.00277)	(0.00280)
$Flood_{t-1}$	--	-0.00256	-0.00298	-0.00259	--	-0.00284	-0.00326	-0.00289
		(0.00285)	(0.00291)	(0.00292)		(0.00288)	(0.00293)	(0.00295)
$Flood_{t-2}$	--	--	-0.00131	-0.000719	--	--	-0.000867	-0.000311
			(0.00298)	(0.00302)			(0.00300)	(0.00304)
$Flood_{t-3}$	--	--	--	-0.000464	--	--	--	-0.000223
				(0.00306)				(0.00308)
$Storm_{t}$	-0.00121	-0.00125	-0.00201	-0.000973	-0.00134	-0.00120	-0.00203	-0.000961
	(0.00202)	(0.00233)	(0.00242)	(0.00249)	(0.00203)	(0.00235)	(0.00244)	(0.00250)
$Storm_{t-1}$	--	0.000408	-0.000270	-0.000413	--	7.22e-05	-0.000645	-0.000799
		(0.00239)	(0.00256)	(0.00262)		(0.00240)	(0.00258)	(0.00264)
$Storm_{t-2}$	--	--	0.00264	0.00408	--	--	0.00260	0.00404
			(0.00249)	(0.00262)			(0.00250)	(0.00264)
$Storm_{t-3}$	--	--	--	-0.00427	--	--	--	**-0.00439***
				(0.00261)				(0.00263)
$Wildfire_{t}$	0.0152	0.0152	0.0144	0.0157	**0.0161***	**0.0163***	0.0153	**0.0166***
	(0.00938)	(0.00971)	(0.00983)	(0.00993)	(0.00947)	(0.00979)	(0.00991)	(0.0100)
$Wildfire_{t-1}$	--	-0.000555	-0.00153	-0.000731	--	0.00123	3.62e-05	0.000741
		(0.0101)	(0.0102)	(0.0103)		(0.0102)	(0.0103)	(0.0104)
$Wildfire_{t-2}$	--	--	0.00546	0.00733	--	--	0.00580	0.00755
			(0.0109)	(0.0110)			(0.0110)	(0.0111)
$Wildfire_{t-3}$	--	--	--	-0.00489	--	--	--	-0.00441
				(0.0116)				(0.0117)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.065	0.066	0.067	0.068	0.073	0.074	0.075	0.076

Note: All regressions are fixed effects linear probability models that include the full set of control variables (same as in Tables). Standard errors in parentheses. Control variable estimates are not displayed. *** p<0.01, ** p<0.05, * p<0.1.

Table C9. Determinants of Civil War Onset : Significant Coefficients from Individual Event Fixed Effects Linear Probabilty Models, 1945-1999 (n=6278)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
$Drought_{t-2}$	-0.0129** to -0.0131*	O3,O4	-0.0114** to -0.0118*	O7,O8
Extreme $Cold_t$	0.0374*** to 0.0408***	O1,O2,O3,O4	0.0372*** to 0.0401***	O5,O6,O7,O8
Extreme $Heat_t$	-0.0263* to -0.0292*	O1,O2,O3,O4	-0.0266* to -0.0277*	O6,O7,O8
Extreme $Heat_{t-1}$	0.0266*	O2	0.0284*	O6
Extreme $Heat_{t-3}$	0.0292*	O4	--	--
$Epidemic_t$	0.00757*	O1	0.00785* to 0.00806*	O5,O6,O7,O8
Control Variables	Yes		Yes	
Country Fixed Effects	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix C Tables C1 through C7. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table C10. Determinants of Civil War Onset : Significant Coefficients from All Events Fixed Effects Linear Probabilty Models, 1945-1999 (n=6278)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
$Drought_{t-2}$	-0.0131** to -0.0132*	O3,O4	-0.0120*	O7,O8
Extreme $Cold_t$	0.0366*** to 0.0415***	O1,O2,O3,O4	0.0364*** to 0.0409***	O5,O6,O7,O8
Extreme $Heat_t$	-0.0280* to -0.0315*	O1,O2,O3,O4	-0.0269* to -0.0296*	O5,O6,O7,O8
Extreme $Heat_{t-1}$	--	--	0.0269*	O6
$Epidemic_t$	--	--	0.00781* to 0.00817*	O5,O6,O7,O8
$Storm_{t-3}$	--	--	-0.00439*	O8
$Wildfire_t$	--	--	0.0161* to 0.0166*	O5,O6,O8
Control Variables	Yes		Yes	
Country Fixed Effects	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix C Table C8. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

D. Civil War Incidence Estimated With Panel Logit Model

In appendix D I estimate equations (3) and (4) using the panel logit econometric method. I also expand equation (3) by adding up to three lags of a given climate change related disaster event, as well as time fixed effects. Table D0 below relates estimated models to econometric specifications in the paper. Tables D1 through D7 provide estimates of models P1 through P8 for each disaster event. Table 8 provides estimates of models P1 through P8 for all disaster events jointly. Table D1 provides estimates for drought events; D2 for extreme cold temperature events; D3 for extreme heat events; D4 for epidemic outbreaks; D5 for flood events; D6 for storm events; and D7 for wildfire events.

Table D0. Description of Appendix D Tables

Model	Lags on a disaster variable	Equivalence to equations in the paper
P1	0	Equation (1)
P2	1	Equation (1)+$Disaster_{t-1}$
P3	2	Equation (1)+$Disaster_{t-1}$+ $Disaster_{t-2}$
P4	3	Equation (1)+$Disaster_{t-1}$+ $Disaster_{t-2}$+ $Disaster_{t-3}$
P5	0	Equation (2)-$Disaster_{t-1}$-$Disaster_{t-2}$-$Disaster_{t-3}$
P6	1	Equation (2)-$Disaster_{t-2}$-$Disaster_{t-3}$
P7	2	Equation (2)-$Disaster_{t-3}$
P8	3	Equation (2)

Table D1. Determinant of Civil War Incidence Controling Frequency for Drought Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Drought_t$	0.160	0.0984	0.0976	0.0944	-0.0460	-0.0369	-0.0294	-0.0279
	(0.172)	(0.181)	(0.182)	(0.182)	(0.180)	(0.189)	(0.189)	(0.189)
$Drought_{t-1}$		0.202	0.194	0.190		-0.0322	0.0140	0.0160
		(0.185)	(0.194)	(0.194)		(0.194)	(0.202)	(0.202)
$Drought_{t-2}$			0.0328	-0.00280			-0.161	-0.141
			(0.189)	(0.198)			(0.197)	(0.206)
$Drought_{t-3}$				0.119				-0.0658
				(0.192)				(0.200)
GDP/capita, lagged	0.0306	0.0310	0.0313	0.0316	-0.353***	-0.353***	-0.357***	-0.358***
	(0.0561)	(0.0565)	(0.0565)	(0.0563)	(0.0696)	(0.0698)	(0.0701)	(0.0702)
log(Population Density)	2.797***	2.790***	2.775***	2.753***	-0.00822	-0.00932	-0.0132	-0.0148
	(0.213)	(0.218)	(0.218)	(0.218)	(0.231)	(0.231)	(0.231)	(0.231)
log(% mountains)	1.488***	1.568***	1.532***	1.511***	0.927***	0.926***	0.926***	0.926***
	(0.319)	(0.326)	(0.332)	(0.330)	(0.244)	(0.244)	(0.244)	(0.244)
1(Noncontiguous state)	-3.237***	-3.278***	-3.254***	-3.237***	-0.137	-0.133	-0.117	-0.110
	(0.735)	(0.764)	(0.747)	(0.740)	(0.655)	(0.655)	(0.656)	(0.656)
1(Oil producer)	-0.717	-0.738	-0.733	-0.729	-1.194**	-1.194**	-1.199**	-1.201**
	(0.453)	(0.460)	(0.455)	(0.453)	(0.489)	(0.489)	(0.490)	(0.490)
1(New State)	0.235	0.249	0.246	0.248	0.610	0.609	0.608	0.607
	(0.384)	(0.384)	(0.384)	(0.384)	(0.412)	(0.412)	(0.412)	(0.412)
1(Instability)	1.161***	1.162***	1.161***	1.162***	1.176***	1.176***	1.177***	1.176***
	(0.143)	(0.144)	(0.143)	(0.143)	(0.150)	(0.150)	(0.150)	(0.151)
PolityIV	0.0201	0.0207	0.0208	0.0211	0.0143	0.0142	0.0138	0.0137
	(0.0141)	(0.0141)	(0.0142)	(0.0142)	(0.0151)	(0.0152)	(0.0152)	(0.0152)
1(Anocracy)	0.990***	0.998***	0.997***	0.997***	1.092***	1.091***	1.089***	1.088***
	(0.151)	(0.152)	(0.151)	(0.151)	(0.158)	(0.158)	(0.159)	(0.159)
Constant	-1.922**	-2.582***	-2.325**	-2.219**	-10.51***	-10.51***	-10.53***	-10.53***
	(0.970)	(0.988)	(1.000)	(0.997)	(1.999)	(2.000)	(2.000)	(2.000)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table D2. Determinant of Civil War Incidence Controling for Frequency of Extreme Cold Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
Extreme Cold$_t$	**1.159*** **	**1.007** **	**0.950** **	**0.940** **	0.625	0.564	0.529	0.528
	(0.434)	(0.447)	(0.451)	(0.450)	(0.420)	(0.429)	(0.430)	(0.431)
Extreme Cold$_{t-1}$		0.775*	0.674	0.655		0.398	0.332	0.329
		(0.470)	(0.475)	(0.476)		(0.451)	(0.459)	(0.462)
Extreme Cold$_{t-2}$			0.765	0.741			0.525	0.522
			(0.504)	(0.506)			(0.490)	(0.493)
Extreme Cold$_{t-3}$				0.280				0.0314
				(0.581)				(0.583)
GDP/capita, lagged	0.0187	0.0119	0.00567	0.00510	-0.354***	-0.356***	-0.360***	-0.360***
	(0.0573)	(0.0578)	(0.0581)	(0.0580)	(0.0697)	(0.0699)	(0.0701)	(0.0701)
log(Population Density)	2.825***	2.814***	2.791***	2.780***	0.0224	0.0326	0.0434	0.0437
	(0.214)	(0.215)	(0.214)	(0.213)	(0.231)	(0.230)	(0.230)	(0.230)
log(% mountains)	1.551***	1.558***	1.515***	1.486***	0.922***	0.919***	0.916***	0.916***
	(0.326)	(0.327)	(0.330)	(0.327)	(0.244)	(0.243)	(0.243)	(0.243)
1(Noncontiguous state)	-3.252***	-3.233***	-3.180***	-3.154***	-0.150	-0.148	-0.142	-0.142
	(0.759)	(0.766)	(0.748)	(0.739)	(0.655)	(0.655)	(0.655)	(0.655)
1(Oil producer)	-0.878*	-0.922*	-0.945**	-0.954**	-1.249**	-1.264**	-1.278**	-1.280**
	(0.475)	(0.482)	(0.480)	(0.480)	(0.498)	(0.501)	(0.503)	(0.503)
1(New State)	0.255	0.268	0.270	0.269	0.623	0.630	0.633	0.633
	(0.384)	(0.384)	(0.383)	(0.383)	(0.411)	(0.410)	(0.410)	(0.410)
1(Instability)	1.167***	1.174***	1.179***	1.181***	1.179***	1.184***	1.189***	1.189***
	(0.144)	(0.144)	(0.144)	(0.144)	(0.150)	(0.150)	(0.150)	(0.151)
PolityIV	0.0154	0.0135	0.0122	0.0118	0.0131	0.0127	0.0123	0.0122
	(0.0142)	(0.0143)	(0.0143)	(0.0144)	(0.0152)	(0.0152)	(0.0152)	(0.0152)
1(Anocracy)	0.976***	0.970***	0.962***	0.960***	1.086***	1.082***	1.080***	1.080***
	(0.152)	(0.152)	(0.151)	(0.151)	(0.158)	(0.158)	(0.158)	(0.158)
Constant	-2.311**	-2.423**	-2.131**	-1.930*	-10.35***	-10.28***	-10.21***	-10.21***
	(0.983)	(0.985)	(0.992)	(0.986)	(1.994)	(1.992)	(1.989)	(1.989)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table D3. Determinant of Civil War Incidence Controling for Frequency of Extreme Heat Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
Extreme Heat$_t$	0.707	0.707	0.693	0.625	0.742	0.716	0.672	0.583
	(0.567)	(0.566)	(0.565)	(0.579)	(0.578)	(0.577)	(0.575)	(0.593)
Extreme Heat$_{t-1}$		**1.029***	**1.008***	**1.025***		**1.053***	**1.003***	**1.027***
		(0.555)	(0.558)	(0.556)		(0.564)	(0.564)	(0.565)
Extreme Heat$_{t-2}$			**1.543*****	**1.526*****			**1.564*****	**1.511*****
			(0.563)	(0.568)			(0.567)	(0.566)
Extreme Heat$_{t-3}$				**1.265****				**1.193****
				(0.595)				(0.607)
GDP/capita, lagged	0.0264	0.0210	0.0145	0.00857	-0.355***	-0.361***	-0.368***	-0.373***
	(0.0564)	(0.0566)	(0.0568)	(0.0573)	(0.0695)	(0.0695)	(0.0697)	(0.0698)
log(Population Density)	2.834***	2.833***	2.839***	2.859***	-0.00141	0.0109	0.0294	0.0447
	(0.213)	(0.213)	(0.214)	(0.218)	(0.230)	(0.230)	(0.230)	(0.230)
log(% mountains)	1.527***	1.498***	1.489***	1.535***	0.917***	0.905***	0.893***	0.888***
	(0.320)	(0.326)	(0.326)	(0.326)	(0.244)	(0.243)	(0.244)	(0.245)
1(Noncontiguous state)	-3.158***	-3.013***	-2.874***	-2.822***	-0.0338	0.0864	0.213	0.272
	(0.756)	(0.751)	(0.755)	(0.774)	(0.657)	(0.658)	(0.658)	(0.658)
1(Oil producer)	-0.735	-0.744	-0.767*	-0.788*	-1.193**	-1.201**	-1.208**	-1.212**
	(0.459)	(0.456)	(0.459)	(0.465)	(0.489)	(0.491)	(0.494)	(0.497)
1(New State)	0.229	0.235	0.249	0.259	0.613	0.617	0.618	0.626
	(0.385)	(0.385)	(0.386)	(0.386)	(0.411)	(0.411)	(0.412)	(0.413)
1(Instability)	1.159***	1.164***	1.184***	1.191***	1.176***	1.181***	1.201***	1.208***
	(0.144)	(0.144)	(0.144)	(0.144)	(0.150)	(0.150)	(0.151)	(0.151)
PolityIV	0.0183	0.0165	0.0133	0.0120	0.0131	0.0115	0.00888	0.00791
	(0.0142)	(0.0142)	(0.0143)	(0.0144)	(0.0152)	(0.0152)	(0.0153)	(0.0153)
1(Anocracy)	0.992***	0.997***	1.011***	1.023***	1.101***	1.109***	1.122***	1.130***
	(0.151)	(0.151)	(0.152)	(0.152)	(0.158)	(0.158)	(0.159)	(0.159)
Constant	-2.116**	-1.979**	-1.956**	-2.262**	-10.47***	-10.40***	-10.34***	-10.28***
	(0.970)	(0.980)	(0.981)	(0.983)	(1.998)	(1.998)	(2.000)	(1.999)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table D4. Determinants of Civil War Incidence Controling for Frequency of Epidemic Outbreaks, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Epidemic_t$	0.127	0.103	0.105	0.102	0.0782	0.0706	0.0719	0.0733
	(0.126)	(0.129)	(0.130)	(0.130)	(0.132)	(0.133)	(0.134)	(0.134)
$Epidemic_{t-1}$		0.144	0.115	0.117		0.0634	0.0490	0.0486
		(0.146)	(0.148)	(0.148)		(0.149)	(0.151)	(0.151)
$Epidemic_{t-2}$			0.238	0.232			0.128	0.131
			(0.164)	(0.166)			(0.169)	(0.170)
$Epidemic_{t-3}$				0.0576				-0.0243
				(0.172)				(0.180)
GDP/capita, lagged	0.0327	0.0345	0.0356	0.0359	-0.347***	-0.344***	-0.341***	-0.341***
	(0.0564)	(0.0563)	(0.0562)	(0.0562)	(0.0696)	(0.0698)	(0.0698)	(0.0699)
log(Population Density)	2.785***	2.742***	2.686***	2.673***	-0.00955	-0.0114	-0.0125	-0.0117
	(0.220)	(0.222)	(0.224)	(0.226)	(0.230)	(0.230)	(0.230)	(0.231)
log(% mountains)	1.555***	1.546***	1.539***	1.534***	0.927***	0.927***	0.928***	0.925***
	(0.325)	(0.324)	(0.324)	(0.323)	(0.244)	(0.244)	(0.244)	(0.246)
1(Noncontiguous state)	-3.265***	-3.249***	-3.246***	-3.243***	-0.152	-0.158	-0.176	-0.179
	(0.757)	(0.756)	(0.755)	(0.754)	(0.654)	(0.654)	(0.654)	(0.655)
1(Oil producer)	-0.734	-0.727	-0.715	-0.714	-1.195**	-1.193**	-1.188**	-1.189**
	(0.461)	(0.463)	(0.466)	(0.466)	(0.490)	(0.491)	(0.492)	(0.492)
1(New State)	0.239	0.249	0.263	0.264	0.615	0.617	0.618	0.619
	(0.385)	(0.384)	(0.384)	(0.384)	(0.411)	(0.411)	(0.410)	(0.411)
1(Instability)	1.165***	1.172***	1.180***	1.182***	1.177***	1.179***	1.182***	1.181***
	(0.144)	(0.144)	(0.144)	(0.144)	(0.150)	(0.150)	(0.150)	(0.151)
PolityIV	0.0193	0.0187	0.0186	0.0186	0.0147	0.0147	0.0148	0.0147
	(0.0141)	(0.0142)	(0.0142)	(0.0142)	(0.0152)	(0.0152)	(0.0152)	(0.0152)
1(Anocracy)	0.981***	0.977***	0.968***	0.966***	1.091***	1.089***	1.085***	1.086***
	(0.152)	(0.152)	(0.152)	(0.152)	(0.158)	(0.158)	(0.158)	(0.158)
Constant	-2.459**	-2.536**	-2.654***	-2.650***	-10.51***	-10.51***	-10.52***	-10.54***
	(0.988)	(0.990)	(0.992)	(0.993)	(2.000)	(2.001)	(2.001)	(2.004)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table D5. Determinant of Civil War Incidence Controling for Frequency of Flood Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Flood_t$	**0.218*** **	**0.169** **	**0.152* **	0.131	0.108	0.0868	0.0764	0.0607
	(0.0747)	(0.0788)	(0.0798)	(0.0814)	(0.0780)	(0.0810)	(0.0819)	(0.0832)
$Flood_{t-1}$		**0.169** **	**0.139* **	0.122		0.0832	0.0655	0.0528
		(0.0804)	(0.0834)	(0.0839)		(0.0834)	(0.0860)	(0.0866)
$Flood_{t-2}$			0.130	0.0909			0.0782	0.0479
			(0.0843)	(0.0876)			(0.0870)	(0.0901)
$Flood_{t-3}$				**0.164* **				0.131
				(0.0898)				(0.0936)
GDP/capita, lagged	0.0207	0.0160	0.0133	0.0121	-0.348***	-0.346***	-0.345***	-0.342***
	(0.0563)	(0.0560)	(0.0559)	(0.0558)	(0.0692)	(0.0690)	(0.0688)	(0.0688)
log(Population Density)	2.638***	2.555***	2.489***	2.434***	0.00154	0.00618	0.00920	0.0109
	(0.218)	(0.218)	(0.219)	(0.221)	(0.230)	(0.229)	(0.228)	(0.227)
log(% mountains)	1.448***	1.425***	1.384***	1.375***	0.909***	0.900***	0.899***	0.890***
	(0.322)	(0.306)	(0.304)	(0.300)	(0.245)	(0.244)	(0.243)	(0.241)
1(Noncontiguous state)	-3.069***	-2.997***	-2.922***	-2.887***	-0.136	-0.132	-0.131	-0.127
	(0.731)	(0.737)	(0.728)	(0.730)	(0.651)	(0.649)	(0.647)	(0.646)
1(Oil producer)	-0.733	-0.744	-0.721	-0.703	-1.194**	-1.190**	-1.178**	-1.165**
	(0.460)	(0.467)	(0.467)	(0.472)	(0.492)	(0.492)	(0.493)	(0.494)
1(New State)	0.218	0.225	0.229	0.233	0.595	0.590	0.589	0.591
	(0.383)	(0.381)	(0.379)	(0.378)	(0.411)	(0.410)	(0.409)	(0.408)
1(Instability)	1.157***	1.149***	1.151***	1.155***	1.174***	1.168***	1.168***	1.170***
	(0.143)	(0.143)	(0.142)	(0.142)	(0.150)	(0.150)	(0.150)	(0.150)
PolityIV	0.0179	0.0173	0.0171	0.0168	0.0146	0.0149	0.0152	0.0156
	(0.0141)	(0.0141)	(0.0141)	(0.0141)	(0.0151)	(0.0151)	(0.0151)	(0.0151)
1(Anocracy)	0.982***	0.989***	0.988***	0.990***	1.096***	1.100***	1.102***	1.105***
	(0.151)	(0.151)	(0.150)	(0.151)	(0.158)	(0.158)	(0.158)	(0.158)
Constant	-2.168**	-2.336**	-2.276**	-2.429***	-10.40***	-10.33***	-10.31***	-10.22***
	(0.976)	(0.945)	(0.940)	(0.933)	(1.993)	(1.989)	(1.982)	(1.979)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table D6. Determinants of Civil War Incidence Controling for Frequency of Storm Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Storm_t$	$\boxed{\textbf{0.142**}}$	0.0859	0.0648	0.0517	0.0916	0.0475	0.0316	0.0193
	(0.0695)	(0.0836)	(0.0863)	(0.0918)	(0.0729)	(0.0859)	(0.0888)	(0.0945)
$Storm_{t-1}$		0.111	0.0796	0.0744		0.0870	0.0632	0.0581
		(0.0864)	(0.0932)	(0.0937)		(0.0893)	(0.0961)	(0.0969)
$Storm_{t-2}$			0.0817	0.0704			0.0624	0.0515
			(0.0893)	(0.0934)			(0.0925)	(0.0968)
$Storm_{t-3}$				0.0405				0.0377
				(0.0960)				(0.100)
GDP/capita, lagged	0.0143	0.00935	0.00745	0.00682	-0.358***	-0.361***	-0.362***	-0.362***
	(0.0572)	(0.0574)	(0.0574)	(0.0574)	(0.0694)	(0.0694)	(0.0694)	(0.0694)
log(Population Density)	2.766***	2.731***	2.717***	2.708***	-0.00400	-0.00358	-0.00434	-0.00434
	(0.216)	(0.215)	(0.215)	(0.215)	(0.230)	(0.230)	(0.230)	(0.229)
log(% mountains)	1.548***	1.501***	1.495***	1.476***	0.918***	0.914***	0.913***	0.913***
	(0.327)	(0.331)	(0.329)	(0.330)	(0.244)	(0.244)	(0.243)	(0.243)
1(Noncontiguous state)	-3.262***	-3.232***	-3.227***	-3.217***	-0.157	-0.167	-0.173	-0.178
	(0.764)	(0.748)	(0.748)	(0.741)	(0.652)	(0.652)	(0.652)	(0.652)
1(Oil producer)	-0.710	-0.695	-0.691	-0.686	-1.167**	-1.160**	-1.159**	-1.158**
	(0.460)	(0.455)	(0.454)	(0.452)	(0.488)	(0.488)	(0.488)	(0.487)
1(New State)	0.234	0.239	0.238	0.235	0.612	0.623	0.622	0.619
	(0.384)	(0.383)	(0.383)	(0.383)	(0.409)	(0.409)	(0.408)	(0.408)
1(Instability)	1.158***	1.158***	1.158***	1.158***	1.173***	1.174***	1.173***	1.173***
	(0.143)	(0.143)	(0.143)	(0.143)	(0.150)	(0.150)	(0.150)	(0.150)
PolityIV	0.0195	0.0194	0.0195	0.0196	0.0151	0.0153	0.0155	0.0157
	(0.0142)	(0.0142)	(0.0142)	(0.0142)	(0.0152)	(0.0152)	(0.0152)	(0.0152)
1(Anocracy)	0.999***	0.997***	1.000***	1.000***	1.102***	1.103***	1.107***	1.108***
	(0.151)	(0.151)	(0.151)	(0.151)	(0.158)	(0.158)	(0.158)	(0.158)
Constant	-2.531***	-2.289**	-2.300**	-2.176**	-10.45***	-10.43***	-10.42***	-10.42***
	(0.982)	(0.988)	(0.985)	(0.985)	(1.996)	(1.996)	(1.996)	(1.996)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table D7. Determinants of Civil War Incidence Controling for Frequency of Wildfire Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Wildfire_t$	0.454	0.426	0.412	0.402	0.103	0.127	0.141	0.141
	(0.349)	(0.355)	(0.357)	(0.357)	(0.367)	(0.371)	(0.372)	(0.373)
$Wildfire_{t-1}$		0.164	0.146	0.144		-0.188	-0.169	-0.169
		(0.401)	(0.404)	(0.403)		(0.412)	(0.415)	(0.415)
$Wildfire_{t-2}$			0.156	0.127			-0.200	-0.199
			(0.438)	(0.440)			(0.455)	(0.457)
$Wildfire_{t-3}$				0.259				-0.0135
				(0.481)				(0.506)
GDP/capita, lagged	0.0264	0.0255	0.0248	0.0228	-0.351***	-0.351***	-0.351***	-0.351***
	(0.0563)	(0.0563)	(0.0565)	(0.0567)	(0.0693)	(0.0694)	(0.0695)	(0.0695)
log(Population Density)	2.818***	2.813***	2.805***	2.812***	-0.000678	-0.00687	-0.0124	-0.0126
	(0.213)	(0.213)	(0.212)	(0.214)	(0.231)	(0.231)	(0.232)	(0.232)
log(% mountains)	1.524***	1.520***	1.498***	1.546***	0.926***	0.927***	0.928***	0.929***
	(0.320)	(0.319)	(0.326)	(0.325)	(0.244)	(0.244)	(0.244)	(0.244)
1(Noncontiguous state)	-3.274***	-3.273***	-3.261***	-3.290***	-0.151	-0.142	-0.134	-0.134
	(0.751)	(0.750)	(0.741)	(0.759)	(0.655)	(0.655)	(0.655)	(0.656)
1(Oil producer)	-0.766*	-0.773*	-0.775*	-0.784*	-1.204**	-1.194**	-1.189**	-1.189**
	(0.463)	(0.464)	(0.462)	(0.468)	(0.492)	(0.491)	(0.490)	(0.490)
1(New State)	0.231	0.231	0.230	0.235	0.611	0.614	0.617	0.617
	(0.385)	(0.385)	(0.385)	(0.385)	(0.411)	(0.411)	(0.411)	(0.411)
1(Instability)	1.165***	1.164***	1.164***	1.167***	1.177***	1.179***	1.178***	1.178***
	(0.144)	(0.144)	(0.144)	(0.144)	(0.150)	(0.150)	(0.150)	(0.150)
PolityIV	0.0174	0.0169	0.0167	0.0161	0.0140	0.0143	0.0146	0.0146
	(0.0142)	(0.0143)	(0.0143)	(0.0143)	(0.0152)	(0.0152)	(0.0152)	(0.0152)
1(Anocracy)	0.985***	0.985***	0.983***	0.987***	1.093***	1.094***	1.095***	1.095***
	(0.151)	(0.151)	(0.151)	(0.151)	(0.158)	(0.158)	(0.158)	(0.158)
Constant	-2.133**	-2.123**	-2.007**	-2.348**	-10.48***	-10.51***	-10.54***	-10.54***
	(0.969)	(0.968)	(0.978)	(0.980)	(1.999)	(2.002)	(2.004)	(2.005)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table D8. Determinants of Civil War Incidence Controling for Frequency of All Disaster Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Drought_{t}$	0.0844	0.0485	0.0331	0.0212	-0.0888	-0.0597	-0.0823	-0.0990
	(0.177)	(0.187)	(0.189)	(0.190)	(0.183)	(0.193)	(0.194)	(0.195)
$Drought_{t-1}$		0.114	0.139	0.151		-0.0980	-0.00793	0.00511
		(0.192)	(0.203)	(0.204)		(0.199)	(0.209)	(0.210)
$Drought_{t-2}$			-0.0544	-0.0644			-0.248	-0.203
			(0.197)	(0.207)			(0.205)	(0.214)
$Drought_{t-3}$				0.0278				-0.159
				(0.201)				(0.209)
Extreme $Cold_{t}$	**0.951****	**0.855***	**0.876***	**0.797***	0.549	0.599	0.649	0.559
	(0.445)	(0.470)	(0.478)	(0.482)	(0.431)	(0.455)	(0.458)	(0.467)
Extreme $Cold_{t-1}$		0.469	0.490	0.500		0.214	0.304	0.330
		(0.492)	(0.509)	(0.507)		(0.476)	(0.499)	(0.490)
Extreme $Cold_{t-2}$			0.403	0.428			0.318	0.382
			(0.552)	(0.560)			(0.541)	(0.553)
Extreme $Cold_{t-3}$				-0.0350				-0.0946
				(0.612)				(0.623)
Extreme $Heat_{t}$	0.535	0.489	0.483	0.522	0.689	0.670	0.690	0.700
	(0.596)	(0.615)	(0.620)	(0.637)	(0.593)	(0.607)	(0.602)	(0.629)
Extreme $Heat_{t-1}$		0.929	0.879	0.860		**1.060***	**1.022***	**1.043***
		(0.583)	(0.600)	(0.600)		(0.577)	(0.594)	(0.595)
Extreme $Heat_{t-2}$			**1.501****	**1.489****			**1.627*****	**1.601*****
			(0.585)	(0.602)			(0.577)	(0.593)
Extreme $Heat_{t-3}$				**1.181***				**1.258****
				(0.611)				(0.610)
$Epidemic_{t}$	0.0740	0.0512	0.0554	0.0519	0.0698	0.0739	0.0885	0.101
	(0.127)	(0.131)	(0.132)	(0.133)	(0.133)	(0.135)	(0.137)	(0.138)
$Epidemic_{t-1}$		0.116	0.101	0.105		0.0646	0.0776	0.0802
		(0.147)	(0.150)	(0.151)		(0.150)	(0.155)	(0.155)
$Epidemic_{t-2}$			0.193	0.193			0.125	0.140
			(0.169)	(0.172)			(0.173)	(0.176)
$Epidemic_{t-3}$				-0.00607				-0.0500
				(0.182)				(0.186)
$Flood_{t}$	**0.165****	0.123	0.122	0.106	0.0789	0.0620	0.0660	0.0515
	(0.0799)	(0.0830)	(0.0839)	(0.0850)	(0.0821)	(0.0848)	(0.0856)	(0.0866)
$Flood_{t-1}$		0.108	0.0862	0.0900		0.0413	0.0330	0.0386
		(0.0859)	(0.0874)	(0.0879)		(0.0884)	(0.0900)	(0.0905)
$Flood_{t-2}$			0.0878	0.0639			0.0431	0.0277
			(0.0893)	(0.0913)			(0.0924)	(0.0946)
$Flood_{t-3}$				0.130				0.101
				(0.0950)				(0.0991)
$Storm_{t}$	0.0690	0.0184	-0.0125	-0.0111	0.0608	0.0253	-0.00521	-0.00781
	(0.0731)	(0.0855)	(0.0888)	(0.0937)	(0.0762)	(0.0884)	(0.0920)	(0.0968)
$Storm_{t-1}$		0.0362	0.0127	-0.00769		0.0484	0.0282	0.0150
		(0.0891)	(0.0959)	(0.0970)		(0.0927)	(0.0995)	(0.101)
$Storm_{t-2}$			0.00990	0.00366			0.0215	0.0132
			(0.0923)	(0.0973)			(0.0958)	(0.101)
$Storm_{t-3}$				-0.0160				0.000718
				(0.0989)				(0.104)
$Wildfire_{t}$	0.238	0.167	0.0143	0.0128	0.0264	0.0238	-0.0819	-0.0540
	(0.364)	(0.378)	(0.401)	(0.409)	(0.377)	(0.387)	(0.412)	(0.420)
$Wildfire_{t-1}$		-0.147	-0.179	-0.269		-0.342	-0.326	-0.406
		(0.420)	(0.436)	(0.453)		(0.424)	(0.438)	(0.455)
$Wildfire_{t-2}$			-0.367	-0.393			-0.509	-0.515
			(0.494)	(0.500)			(0.494)	(0.504)
$Wildfire_{t-3}$				-0.208				-0.396
				(0.538)				(0.541)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models that include the full set of control variables (same as in Tables). Standard errors in parentheses. Control variable estimates are not displayed. *** p<0.01, ** p<0.05, * p<0.1.

E. Civil War Incidence Estimated With Conditional (Fixed Effects) Logit Model

In appendix E I estimate equations (3) and (4) using the conditional (fixed effects) logit econometric method. I also expand equation (3) by adding up to three lags of a given climate change related disaster event, as well as time fixed effects. Table E0 below relates estimated models to econometric specifications in the paper. Tables E1 through E7 provide estimates of models P1 through P8 for each disaster event. Table E8 provides estimates of models P1 through P8 for all disaster events jointly. Table E1 provides estimates for drought events; E2 for extreme cold temperature events; E3 for extreme heat events; E4 for epidemic outbreaks; E5 for flood events; E6 for storm events; and E7 for wildfire events.

Table E0. Description of Appendix E Tables

Model	Lags on a disaster variable	Equivalence to equations in the paper
P1	0	Equation (1)
P2	1	Equation (1)+Disaster_{t-1}
P3	2	Equation (1)+Disaster_{t-1}+ Disaster_{t-2}
P4	3	Equation (1)+Disaster_{t-1}+ Disaster_{t-2}+ Disaster_{t-3}
P5	0	Equation (2)-Disaster_{t-1}-Disaster_{t-2}-Disaster_{t-3}
P6	1	Equation (2)-Disaster_{t-2}-Disaster_{t-3}
P7	2	Equation (2)-Disaster_{t-3}
P8	3	Equation (2)

Table E1. Determinants of Civil War Incidence Controling Frequency for Drought Events, 1945-1999 (n=2659)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Drought_t$	0.0937	0.0486	0.0497	0.0478	-0.0334	-0.0311	-0.0246	-0.0234
	(0.173)	(0.181)	(0.182)	(0.182)	(0.181)	(0.189)	(0.189)	(0.189)
$Drought_{t-1}$	--	0.154	0.161	0.159	--	-0.00826	0.0330	0.0346
		(0.185)	(0.193)	(0.193)		(0.195)	(0.202)	(0.202)
$Drought_{t-2}$	--	--	-0.0209	-0.0391	--	--	-0.146	-0.130
			(0.188)	(0.197)			(0.197)	(0.205)
$Drought_{t-3}$	--	--	--	0.0596	--	--	--	-0.0552
				(0.191)				(0.200)
GDP/capita, lagged	0.0813	0.0823	0.0822	0.0824	-0.231**	-0.232**	-0.237**	-0.238**
	(0.0647)	(0.0647)	(0.0647)	(0.0647)	(0.0958)	(0.0962)	(0.0966)	(0.0968)
log(Population Density)	3.137***	3.117***	3.120***	3.112***	0.111	0.110	0.0886	0.0815
	(0.234)	(0.236)	(0.237)	(0.238)	(0.627)	(0.628)	(0.629)	(0.629)
1(Noncontiguous state)	-4.090***	-4.091***	-4.091***	-4.090***	-2.083*	-2.081*	-2.052*	-2.040*
	(1.118)	(1.117)	(1.117)	(1.117)	(1.202)	(1.203)	(1.204)	(1.205)
1(Oil producer)	-1.074**	-1.082**	-1.082**	-1.082**	-1.680***	-1.680***	-1.687***	-1.690***
	(0.480)	(0.480)	(0.480)	(0.480)	(0.552)	(0.552)	(0.553)	(0.553)
1(New State)	0.340	0.345	0.345	0.346	0.606	0.606	0.607	0.607
	(0.383)	(0.383)	(0.383)	(0.383)	(0.421)	(0.421)	(0.422)	(0.422)
1(Instability)	1.132***	1.131***	1.132***	1.132***	1.157***	1.157***	1.158***	1.157***
	(0.144)	(0.144)	(0.144)	(0.144)	(0.150)	(0.151)	(0.151)	(0.151)
PolityIV	0.0191	0.0197	0.0196	0.0198	0.0136	0.0136	0.0131	0.0130
	(0.0144)	(0.0145)	(0.0145)	(0.0145)	(0.0158)	(0.0158)	(0.0158)	(0.0158)
1(Anocracy)	1.050***	1.053***	1.053***	1.053***	1.116***	1.116***	1.113***	1.113***
	(0.154)	(0.154)	(0.154)	(0.154)	(0.161)	(0.161)	(0.162)	(0.162)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table E2. Determinants of Civil War Incidence Controling for Frequency of Extreme Cold Events, 1945-1999 (n=2659)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
Extreme Cold$_t$	**1.097****	**0.955****	**0.903****	**0.895****	0.626	0.576	0.550	0.550
	(0.442)	(0.455)	(0.457)	(0.456)	(0.439)	(0.446)	(0.446)	(0.447)
Extreme Cold$_{t-1}$	--	0.665	0.569	0.554	--	0.330	0.271	0.269
		(0.478)	(0.481)	(0.482)		(0.463)	(0.468)	(0.471)
Extreme Cold$_{t-2}$	--	--	0.672	0.652	--	--	0.469	0.467
			(0.516)	(0.518)			(0.501)	(0.504)
Extreme Cold$_{t-3}$	--	--	--	0.217	--	--	--	0.0249
				(0.587)				(0.598)
GDP/capita, lagged	0.0706	0.0646	0.0587	0.0581	-0.217**	-0.215**	-0.214**	-0.214**
	(0.0655)	(0.0659)	(0.0663)	(0.0664)	(0.0962)	(0.0964)	(0.0966)	(0.0967)
log(Population Density)	3.138***	3.126***	3.118***	3.116***	0.314	0.373	0.443	0.445
	(0.232)	(0.232)	(0.232)	(0.232)	(0.642)	(0.648)	(0.654)	(0.656)
1(Noncontiguous state)	-4.067***	-4.051***	-4.028***	-4.021***	-2.214*	-2.249*	-2.284*	-2.285*
	(1.118)	(1.119)	(1.119)	(1.119)	(1.205)	(1.207)	(1.208)	(1.208)
1(Oil producer)	-1.243**	-1.285**	-1.317***	-1.331***	-1.758***	-1.775***	-1.794***	-1.795***
	(0.498)	(0.503)	(0.507)	(0.509)	(0.561)	(0.563)	(0.565)	(0.566)
1(New State)	0.360	0.370	0.377	0.379	0.607	0.611	0.610	0.610
	(0.383)	(0.382)	(0.382)	(0.382)	(0.420)	(0.420)	(0.420)	(0.420)
1(Instability)	1.135***	1.141***	1.146***	1.149***	1.158***	1.162***	1.166***	1.166***
	(0.144)	(0.144)	(0.144)	(0.144)	(0.150)	(0.151)	(0.151)	(0.151)
PolityIV	0.0148	0.0132	0.0120	0.0116	0.0131	0.0129	0.0127	0.0126
	(0.0146)	(0.0146)	(0.0146)	(0.0147)	(0.0158)	(0.0158)	(0.0158)	(0.0158)
1(Anocracy)	1.034***	1.027***	1.023***	1.023***	1.115***	1.112***	1.112***	1.112***
	(0.154)	(0.154)	(0.154)	(0.154)	(0.161)	(0.161)	(0.161)	(0.161)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table E3. Determinants of Civil War Incidence Controling for Frequency of Extreme Heat Events, 1945-1999 (n=2659)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
Extreme Heat$_t$	0.590	0.596	0.593	0.532	0.527	0.520	0.502	0.415
	(0.571)	(0.570)	(0.569)	(0.582)	(0.587)	(0.587)	(0.584)	(0.602)
Extreme Heat$_{t-1}$	--	**0.941***	**0.926***	**0.947***	--	0.891	0.872	0.908
		(0.554)	(0.557)	(0.554)		(0.568)	(0.573)	(0.572)
Extreme Heat$_{t-2}$	--	--	**1.470*****	**1.459****	--	--	**1.450****	**1.421****
			(0.566)	(0.570)			(0.579)	(0.581)
Extreme Heat$_{t-3}$	--	--	--	**1.216****	--	--	--	**1.121***
				(0.593)				(0.616)
GDP/capita, lagged	0.0777	0.0724	0.0655	0.0596	-0.232**	-0.232**	-0.233**	-0.231**
	(0.0648)	(0.0649)	(0.0651)	(0.0654)	(0.0954)	(0.0953)	(0.0954)	(0.0954)
log(Population Density)	3.153***	3.159***	3.167***	3.179***	0.136	0.195	0.282	0.363
	(0.232)	(0.233)	(0.233)	(0.234)	(0.626)	(0.628)	(0.631)	(0.634)
1(Noncontiguous state)	-3.974***	-3.816***	-3.648***	-3.547***	-1.990*	-1.864	-1.709	-1.647
	(1.124)	(1.127)	(1.127)	(1.125)	(1.206)	(1.209)	(1.211)	(1.211)
1(Oil producer)	-1.084**	-1.097**	-1.123**	-1.143**	-1.680***	-1.689***	-1.703***	-1.719***
	(0.482)	(0.482)	(0.484)	(0.486)	(0.553)	(0.555)	(0.558)	(0.560)
1(New State)	0.335	0.343	0.357	0.364	0.606	0.606	0.601	0.604
	(0.384)	(0.384)	(0.384)	(0.384)	(0.421)	(0.421)	(0.422)	(0.422)
1(Instability)	1.129***	1.133***	1.153***	1.160***	1.156***	1.160***	1.179***	1.187***
	(0.144)	(0.144)	(0.145)	(0.145)	(0.151)	(0.151)	(0.151)	(0.151)
PolityIV	0.0177	0.0161	0.0131	0.0120	0.0129	0.0117	0.00946	0.00880
	(0.0145)	(0.0146)	(0.0147)	(0.0147)	(0.0158)	(0.0159)	(0.0159)	(0.0160)
1(Anocracy)	1.051***	1.057***	1.070***	1.080***	1.123***	1.130***	1.144***	1.153***
	(0.154)	(0.154)	(0.154)	(0.155)	(0.161)	(0.161)	(0.162)	(0.162)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table E4. Determinants of Civil War Incidence Controling for Frequency of Epidemic Outbreaks, 1945-1999 (n=2659)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Epidemic_{t}$	0.0541	0.0419	0.0441	0.0453	0.0767	0.0702	0.0730	0.0746
	(0.127)	(0.129)	(0.130)	(0.130)	(0.133)	(0.134)	(0.135)	(0.135)
$Epidemic_{t-1}$	--	0.0768	0.0578	0.0573	--	0.0598	0.0462	0.0457
		(0.146)	(0.148)	(0.148)		(0.151)	(0.153)	(0.153)
$Epidemic_{t-2}$	--	--	0.164	0.166	--	--	0.130	0.133
			(0.166)	(0.167)			(0.171)	(0.172)
$Epidemic_{t-3}$	--	--	--	-0.0175	--	--	--	-0.0242
				(0.172)				(0.181)
GDP/capita, lagged	0.0826	0.0839	0.0853	0.0851	-0.225**	-0.222**	-0.218**	-0.218**
	(0.0648)	(0.0649)	(0.0649)	(0.0649)	(0.0956)	(0.0958)	(0.0958)	(0.0959)
log(Population Density)	3.129***	3.106***	3.066***	3.070***	0.112	0.107	0.106	0.108
	(0.239)	(0.243)	(0.246)	(0.248)	(0.625)	(0.625)	(0.624)	(0.625)
1(Noncontiguous state)	-4.089***	-4.086***	-4.101***	-4.100***	-2.101*	-2.106*	-2.137*	-2.133*
	(1.117)	(1.117)	(1.119)	(1.119)	(1.201)	(1.201)	(1.202)	(1.203)
1(Oil producer)	-1.079**	-1.078**	-1.075**	-1.074**	-1.688***	-1.688***	-1.686***	-1.685***
	(0.481)	(0.482)	(0.485)	(0.485)	(0.554)	(0.555)	(0.556)	(0.556)
1(New State)	0.338	0.343	0.352	0.351	0.608	0.610	0.611	0.610
	(0.384)	(0.383)	(0.383)	(0.383)	(0.421)	(0.420)	(0.420)	(0.420)
1(Instability)	1.133***	1.137***	1.142***	1.142***	1.157***	1.160***	1.163***	1.162***
	(0.144)	(0.144)	(0.144)	(0.144)	(0.150)	(0.151)	(0.151)	(0.151)
PolityIV	0.0187	0.0185	0.0184	0.0183	0.0142	0.0142	0.0143	0.0143
	(0.0145)	(0.0145)	(0.0145)	(0.0145)	(0.0158)	(0.0158)	(0.0158)	(0.0159)
1(Anocracy)	1.044***	1.042***	1.036***	1.037***	1.114***	1.113***	1.108***	1.109***
	(0.154)	(0.154)	(0.154)	(0.154)	(0.161)	(0.161)	(0.161)	(0.161)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table E5. Determinants of Civil War Incidence Controling for Frequency of Flood Events, 1945-1999 (n=2659)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Flood_t$	$\boxed{\textbf{0.150**}}$	0.115	0.103	0.0866	0.0804	0.0653	0.0578	0.0442
	(0.0745)	(0.0783)	(0.0792)	(0.0806)	(0.0780)	(0.0807)	(0.0815)	(0.0828)
$Flood_{t-1}$	--	0.121	0.101	0.0881	--	0.0621	0.0492	0.0376
		(0.0799)	(0.0826)	(0.0831)		(0.0832)	(0.0856)	(0.0861)
$Flood_{t-2}$	--	--	0.0841	0.0536	--	--	0.0582	0.0303
			(0.0837)	(0.0868)			(0.0866)	(0.0897)
$Flood_{t-3}$	--	--	--	0.125	--	--	--	0.120
				(0.0897)				(0.0938)
GDP/capita, lagged	0.0765	0.0744	0.0732	0.0734	-0.219**	-0.213**	-0.210**	-0.202**
	(0.0650)	(0.0651)	(0.0652)	(0.0653)	(0.0959)	(0.0962)	(0.0963)	(0.0966)
log(Population Density)	3.026***	2.964***	2.926***	2.882***	0.191	0.233	0.258	0.301
	(0.239)	(0.242)	(0.245)	(0.247)	(0.629)	(0.632)	(0.633)	(0.634)
1(Noncontiguous state)	-3.974***	-3.920***	-3.883***	-3.859***	-2.118*	-2.134*	-2.139*	-2.169*
	(1.117)	(1.116)	(1.116)	(1.116)	(1.201)	(1.200)	(1.199)	(1.200)
1(Oil producer)	-1.100**	-1.115**	-1.106**	-1.098**	-1.684***	-1.681***	-1.670***	-1.660***
	(0.485)	(0.487)	(0.488)	(0.490)	(0.554)	(0.554)	(0.555)	(0.555)
1(New State)	0.331	0.336	0.341	0.344	0.586	0.578	0.575	0.573
	(0.382)	(0.381)	(0.380)	(0.379)	(0.421)	(0.421)	(0.420)	(0.419)
1(Instability)	1.128***	1.121***	1.123***	1.127***	1.154***	1.149***	1.149***	1.152***
	(0.144)	(0.143)	(0.143)	(0.143)	(0.150)	(0.150)	(0.150)	(0.150)
PolityIV	0.0178	0.0174	0.0173	0.0171	0.0143	0.0148	0.0151	0.0157
	(0.0144)	(0.0144)	(0.0144)	(0.0144)	(0.0158)	(0.0158)	(0.0158)	(0.0158)
1(Anocracy)	1.046***	1.051***	1.050***	1.051***	1.120***	1.124***	1.125***	1.130***
	(0.153)	(0.153)	(0.153)	(0.153)	(0.161)	(0.161)	(0.161)	(0.161)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table E6. Determinants of Civil War Incidence Controling for Frequency of Storm Events, 1945-1999 (n=2659)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Storm_t$	0.108	0.0625	0.0452	0.0357	0.0731	0.0340	0.0194	0.00696
	(0.0723)	(0.0851)	(0.0879)	(0.0939)	(0.0750)	(0.0877)	(0.0905)	(0.0967)
$Storm_{t-1}$	--	0.0886	0.0642	0.0604	--	0.0783	0.0570	0.0521
		(0.0890)	(0.0953)	(0.0959)		(0.0923)	(0.0990)	(0.0996)
$Storm_{t-2}$	--	--	0.0651	0.0573	--	--	0.0565	0.0460
			(0.0914)	(0.0953)			(0.0947)	(0.0991)
$Storm_{t-3}$	--	--	--	0.0279	--	--	--	0.0370
				(0.0979)				(0.103)
GDP/capita, lagged	0.0700	0.0663	0.0649	0.0644	-0.230**	-0.231**	-0.230**	-0.230**
	(0.0653)	(0.0654)	(0.0655)	(0.0655)	(0.0954)	(0.0955)	(0.0955)	(0.0955)
log(Population Density)	3.092***	3.071***	3.060***	3.058***	0.167	0.187	0.194	0.198
	(0.235)	(0.236)	(0.236)	(0.236)	(0.626)	(0.626)	(0.626)	(0.626)
1(Noncontiguous state)	-4.068***	-4.059***	-4.054***	-4.055***	-2.131*	-2.147*	-2.154*	-2.161*
	(1.118)	(1.118)	(1.117)	(1.117)	(1.201)	(1.201)	(1.201)	(1.201)
1(Oil producer)	-1.063**	-1.056**	-1.052**	-1.051**	-1.658***	-1.650***	-1.650***	-1.649***
	(0.480)	(0.479)	(0.479)	(0.479)	(0.551)	(0.550)	(0.550)	(0.550)
1(New State)	0.337	0.344	0.343	0.342	0.602	0.611	0.608	0.605
	(0.382)	(0.382)	(0.382)	(0.382)	(0.419)	(0.419)	(0.418)	(0.418)
1(Instability)	1.128***	1.129***	1.128***	1.128***	1.155***	1.155***	1.154***	1.154***
	(0.144)	(0.144)	(0.144)	(0.144)	(0.150)	(0.150)	(0.150)	(0.150)
PolityIV	0.0189	0.0188	0.0189	0.0190	0.0146	0.0149	0.0151	0.0154
	(0.0145)	(0.0145)	(0.0145)	(0.0145)	(0.0158)	(0.0158)	(0.0158)	(0.0159)
1(Anocracy)	1.053***	1.053***	1.055***	1.056***	1.125***	1.127***	1.130***	1.132***
	(0.153)	(0.153)	(0.153)	(0.153)	(0.161)	(0.161)	(0.161)	(0.161)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table E7. Determinants of Civil War Incidence Controling for Frequency of Wildfire Events, 1945-1999 (n=2659)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Wildfire_{t}$	0.374	0.360	0.351	0.345	0.138	0.156	0.166	0.166
	(0.352)	(0.356)	(0.358)	(0.358)	(0.369)	(0.372)	(0.373)	(0.373)
$Wildfire_{t-1}$	--	0.0917	0.0796	0.0805	--	-0.169	-0.155	-0.156
		(0.403)	(0.405)	(0.405)		(0.408)	(0.411)	(0.411)
$Wildfire_{t-2}$	--	--	0.110	0.0901	--	--	-0.172	-0.171
			(0.441)	(0.442)			(0.454)	(0.456)
$Wildfire_{t-3}$	--	--	--	0.190	--	--	--	-0.0150
				(0.484)				(0.503)
GDP/capita, lagged	0.0787	0.0784	0.0780	0.0769	-0.226**	-0.229**	-0.231**	-0.231**
	(0.0648)	(0.0648)	(0.0649)	(0.0650)	(0.0959)	(0.0963)	(0.0966)	(0.0966)
log(Population Density)	3.138***	3.135***	3.133***	3.130***	0.164	0.130	0.102	0.100
	(0.233)	(0.233)	(0.233)	(0.233)	(0.636)	(0.642)	(0.646)	(0.648)
1(Noncontiguous state)	-4.096***	-4.096***	-4.096***	-4.097***	-2.128*	-2.100*	-2.079*	-2.077*
	(1.118)	(1.117)	(1.117)	(1.117)	(1.205)	(1.206)	(1.208)	(1.209)
1(Oil producer)	-1.116**	-1.121**	-1.126**	-1.130**	-1.699***	-1.686***	-1.679***	-1.679***
	(0.485)	(0.486)	(0.487)	(0.488)	(0.556)	(0.555)	(0.555)	(0.555)
1(New State)	0.337	0.337	0.337	0.337	0.602	0.608	0.612	0.613
	(0.384)	(0.384)	(0.384)	(0.383)	(0.421)	(0.421)	(0.422)	(0.422)
1(Instability)	1.134***	1.134***	1.134***	1.136***	1.158***	1.160***	1.159***	1.159***
	(0.144)	(0.144)	(0.144)	(0.144)	(0.150)	(0.151)	(0.151)	(0.151)
PolityIV	0.0169	0.0166	0.0164	0.0160	0.0134	0.0136	0.0137	0.0138
	(0.0146)	(0.0146)	(0.0146)	(0.0147)	(0.0158)	(0.0158)	(0.0158)	(0.0159)
1(Anocracy)	1.046***	1.046***	1.045***	1.046***	1.118***	1.117***	1.118***	1.118***
	(0.154)	(0.154)	(0.154)	(0.154)	(0.161)	(0.161)	(0.161)	(0.161)
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are conditional (fixed effects) logit models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table E8. Determinants of Civil War Incidence Controling for Frequency of All Disaster Events, 1945-1999 (n=2659)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Drought_t$	0.0345	0.0127	-0.00364	-0.0155	-0.0627	-0.0426	-0.0699	-0.0853
	(0.177)	(0.186)	(0.189)	(0.189)	(0.184)	(0.193)	(0.195)	(0.196)
$Drought_{t-1}$	--	0.0753	0.119	0.127	--	-0.0634	0.0166	0.0263
		(0.191)	(0.201)	(0.203)		(0.199)	(0.209)	(0.211)
$Drought_{t-2}$	--	--	-0.0945	-0.0875	--	--	-0.216	-0.177
			(0.196)	(0.206)			(0.205)	(0.214)
$Drought_{t-3}$	--	--	--	-0.0181	--	--	--	-0.136
				(0.199)				(0.209)
Extreme $Cold_t$	**0.948****	**0.877***	**0.922***	**0.846***	0.563	0.619	0.695	0.591
	(0.453)	(0.481)	(0.492)	(0.495)	(0.447)	(0.474)	(0.483)	(0.491)
Extreme $Cold_{t-1}$	--	0.436	0.484	0.503	--	0.175	0.261	0.314
		(0.498)	(0.520)	(0.521)		(0.486)	(0.511)	(0.509)
Extreme $Cold_{t-2}$	--	--	0.372	0.410	--	--	0.250	0.310
			(0.560)	(0.571)			(0.552)	(0.568)
Extreme $Cold_{t-3}$	--	--	--	-0.0491	--	--	--	-0.120
				(0.616)				(0.642)
Extreme $Heat_t$	0.454	0.418	0.442	0.503	0.481	0.476	0.523	0.543
	(0.599)	(0.617)	(0.620)	(0.641)	(0.603)	(0.618)	(0.614)	(0.647)
Extreme $Heat_{t-1}$	--	0.889	0.852	0.856	--	0.914	0.895	0.931
		(0.577)	(0.591)	(0.590)		(0.580)	(0.599)	(0.599)
Extreme $Heat_{t-2}$	--	--	**1.475****	**1.480****	--	--	**1.534*****	**1.518****
			(0.585)	(0.603)			(0.591)	(0.610)
Extreme $Heat_{t-3}$	--	--	--	**1.170***	--	--	--	**1.189***
				(0.607)				(0.622)
$Epidemic_t$	0.00549	-0.00505	-0.00252	0.00240	0.0664	0.0693	0.0813	0.0941
	(0.128)	(0.130)	(0.131)	(0.132)	(0.133)	(0.136)	(0.138)	(0.139)
$Epidemic_{t-1}$	--	0.0532	0.0527	0.0504	--	0.0602	0.0727	0.0732
		(0.147)	(0.150)	(0.150)		(0.152)	(0.156)	(0.157)
$Epidemic_{t-2}$	--	--	0.122	0.134	--	--	0.125	0.141
			(0.171)	(0.173)			(0.176)	(0.178)
$Epidemic_{t-3}$	--	--	--	-0.0736	--	--	--	-0.0481
				(0.181)				(0.188)
$Flood_t$	0.108	0.0795	0.0791	0.0679	0.0581	0.0467	0.0508	0.0395
	(0.0794)	(0.0827)	(0.0835)	(0.0842)	(0.0823)	(0.0849)	(0.0857)	(0.0866)
$Flood_{t-1}$	--	0.0641	0.0534	0.0567	--	0.0223	0.0187	0.0240
		(0.0852)	(0.0868)	(0.0870)		(0.0882)	(0.0898)	(0.0902)
$Flood_{t-2}$	--	--	0.0444	0.0309	--	--	0.0274	0.0139
			(0.0885)	(0.0903)			(0.0923)	(0.0944)
$Flood_{t-3}$	--	--	--	0.0918	--	--	--	0.0907
				(0.0942)				(0.0995)
$Storm_t$	0.0525	0.0136	-0.00814	-0.00309	0.0484	0.0168	-0.00999	-0.0127
	(0.0751)	(0.0865)	(0.0907)	(0.0960)	(0.0779)	(0.0895)	(0.0937)	(0.0991)
$Storm_{t-1}$	--	0.0311	0.0127	-0.000748	--	0.0463	0.0268	0.0156
		(0.0909)	(0.0969)	(0.0987)		(0.0948)	(0.101)	(0.103)
$Storm_{t-2}$	--	--	0.0100	0.00791	--	--	0.0221	0.0130
			(0.0936)	(0.0983)			(0.0973)	(0.103)
$Storm_{t-3}$	--	--	--	-0.0202	--	--	--	0.00202
				(0.101)				(0.107)
$Wildfire_t$	0.209	0.163	0.0182	0.0271	0.0922	0.0993	-0.00820	0.0230
	(0.363)	(0.375)	(0.394)	(0.402)	(0.377)	(0.386)	(0.410)	(0.417)
$Wildfire_{t-1}$	--	-0.156	-0.176	-0.265	--	-0.285	-0.266	-0.342
		(0.415)	(0.433)	(0.444)		(0.420)	(0.436)	(0.450)
$Wildfire_{t-2}$	--	--	-0.382	-0.386	--	--	-0.450	-0.443
			(0.489)	(0.496)			(0.494)	(0.504)
$Wildfire_{t-3}$	--	--	--	-0.268	--	--	--	-0.352
				(0.539)				(0.542)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: All regressions are panel logit models that include the full set of control variables (same as in Tables). Standard errors in parentheses. Control variable estimates are not displayed. *** p<0.01, ** p<0.05, * p<0.1.

Table E9. Determinants of Civil War Incidence : Significant Coefficients from Individual Event Conditional (Fixed Effects) Logit Models, 1945-1999 (n=2659)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
Extreme Cold$_t$	0.895** to 1.097**	P1,P2,P3,P4	--	--
Extreme Heat$_{t-1}$	0.926* to 0.947*	P2,P3,P4	--	--
Extreme Heat$_{t-2}$	1.459** to 1.47***	P3,P4	1.421** to 1.450**	P7,P8
Extreme Heat$_{t-3}$	1.216**	P4	1.121*	P8
Flood$_t$	0.150**	P1	--	--
Control Variables	Yes		Yes	
Country Fixed Effects	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix E Tables E1 through E7. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table E10. Determinants of Civil War Incidence : Significant Coefficients from All Events Conditional (Fixed Effects) Logit Models, 1945-1999 (n=2659)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
Extreme Cold$_t$	0.846* to 0.948**	P1,P2,P3,P4	--	--
Extreme Heat$_{t-2}$	1.475** to 1.480**	P3,P4	1.518** to 1.534***	P7,P8
Extreme Heat$_{t-3}$	1.170*	P4	1.189*	P8
Flood$_t$	0.150**	P1	--	--
Control Variables	Yes		Yes	
Country Fixed Effects	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix E Table E8. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

F. Civil War Incidence Estimated With Fixed Effects Linear Probability Model

In appendix F I estimate equations (3) and (4) using the fixed effects linear probability econometric method. I also expand equation (3) by adding up to three lags of a given climate change related disaster event, as well as time fixed effects. Table F0 below relates estimated models to econometric specifications in the paper. Tables F1 through F7 provide estimates of models P1 through P8 for each disaster event. Table F8 provides estimates of models P1 through P8 for all disaster events jointly. Table F1 provides estimates for drought events; F2 for extreme cold temperature events; F3 for extreme heat events; F4 for epidemic outbreaks; F5 for flood events; F6 for storm events; and F7 for wildfire events.

Table F0. Description of Appendix F Tables

Model	Lags on a disaster variable	Equivalence to equations in the paper
P1	0	Equation (1)
P2	1	Equation (1)+$Disaster_{t-1}$
P3	2	Equation (1)+$Disaster_{t-1}$+ $Disaster_{t-2}$
P4	3	Equation (1)+$Disaster_{t-1}$+ $Disaster_{t-2}$+ $Disaster_{t-3}$
P5	0	Equation (2)-$Disaster_{t-1}$-$Disaster_{t-2}$-$Disaster_{t-3}$
P6	1	Equation (2)-$Disaster_{t-2}$-$Disaster_{t-3}$
P7	2	Equation (2)-$Disaster_{t-3}$
P8	3	Equation (2)

Table F1. Determinants of Civil War Incidence Controling Frequency for Drought Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Drought_t$	0.0143	0.00946	0.00914	0.00872	0.00866	0.00638	0.00637	0.00617
	(0.0117)	(0.0122)	(0.0122)	(0.0122)	(0.0118)	(0.0124)	(0.0124)	(0.0124)
$Drought_{t-1}$	--	0.0166	0.0143	0.0139	--	0.00799	0.00792	0.00770
		(0.0125)	(0.0130)	(0.0130)		(0.0127)	(0.0132)	(0.0132)
$Drought_{t-2}$	--	--	0.00761	0.00381	--	--	0.000254	-0.00141
			(0.0127)	(0.0133)			(0.0129)	(0.0135)
$Drought_{t-3}$	--	--	--	0.0127	--	--	--	0.00577
				(0.0130)				(0.0132)
GDP/capita, lagged	-0.00277*	-0.00279*	-0.00281*	-0.00282*	-0.0135***	-0.0135***	-0.0135***	-0.0135***
	(0.00163)	(0.00163)	(0.00163)	(0.00163)	(0.00224)	(0.00224)	(0.00224)	(0.00224)
log(Population Density)	0.189***	0.188***	0.187***	0.186***	0.0247	0.0247	0.0247	0.0246
	(0.0115)	(0.0116)	(0.0116)	(0.0117)	(0.0253)	(0.0253)	(0.0253)	(0.0253)
log(% mountains)	0.0596***	0.0596***	0.0595***	0.0593***	0.0895***	0.0894***	0.0894***	0.0892***
	(0.0206)	(0.0206)	(0.0206)	(0.0206)	(0.0211)	(0.0211)	(0.0211)	(0.0211)
1(Noncontiguous state)	-0.505***	-0.505***	-0.506***	-0.506***	-0.384***	-0.384***	-0.384***	-0.385***
	(0.0684)	(0.0684)	(0.0684)	(0.0684)	(0.0702)	(0.0702)	(0.0702)	(0.0702)
1(Oil producer)	-0.0373*	-0.0373*	-0.0373*	-0.0373*	-0.0441**	-0.0441**	-0.0441**	-0.0440**
	(0.0202)	(0.0202)	(0.0202)	(0.0202)	(0.0203)	(0.0203)	(0.0203)	(0.0203)
1(New State)	0.0279	0.0286	0.0288	0.0294	0.0418*	0.0420*	0.0420*	0.0422*
	(0.0213)	(0.0213)	(0.0213)	(0.0213)	(0.0219)	(0.0219)	(0.0219)	(0.0219)
1(Instability)	0.0995***	0.0994***	0.0994***	0.0994***	0.0981***	0.0980***	0.0980***	0.0980***
	(0.00994)	(0.00994)	(0.00994)	(0.00994)	(0.00997)	(0.00997)	(0.00997)	(0.00997)
PolityIV	0.000301	0.000302	0.000297	0.000288	-0.000448	-0.000450	-0.000450	-0.000456
	(0.000831)	(0.000831)	(0.000831)	(0.000831)	(0.000877)	(0.000877)	(0.000878)	(0.000878)
1(Anocracy)	0.0711***	0.0714***	0.0715***	0.0718***	0.0730***	0.0732***	0.0732***	0.0733***
	(0.00965)	(0.00965)	(0.00965)	(0.00966)	(0.00971)	(0.00971)	(0.00971)	(0.00972)
Constant	1.068***	1.063***	1.061***	1.058***	0.273*	0.274*	0.274*	0.275*
	(0.0943)	(0.0943)	(0.0944)	(0.0944)	(0.150)	(0.150)	(0.150)	(0.150)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.525	0.525	0.525	0.525	0.532	0.532	0.532	0.532

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table F2. Determinants of Civil War Incidence Controling for Frequency of Extreme Cold Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
Extreme Cold$_t$	**0.0696*** **	**0.0605** **	**0.0580** **	**0.0578** **	**0.0523** **	**0.0460* **	**0.0442* **	**0.0443* **
	(0.0250)	(0.0254)	(0.0254)	(0.0254)	(0.0252)	(0.0256)	(0.0256)	(0.0256)
Extreme Cold$_{t-1}$	--	0.0501*	0.0429	0.0427	--	0.0363	0.0309	0.0309
		(0.0261)	(0.0264)	(0.0264)		(0.0263)	(0.0266)	(0.0266)
Extreme Cold$_{t-2}$	--	--	**0.0466* **	**0.0458* **	--	--	0.0365	0.0371
			(0.0269)	(0.0272)			(0.0271)	(0.0273)
Extreme Cold$_{t-3}$	--	--	--	0.00712	--	--	--	-0.00465
				(0.0292)				(0.0294)
GDP/capita, lagged	-0.00291*	-0.00302*	-0.00312*	-0.00314*	-0.0134***	-0.0133***	-0.0133***	-0.0133***
	(0.00163)	(0.00163)	(0.00163)	(0.00163)	(0.00224)	(0.00224)	(0.00224)	(0.00224)
log(Population Density)	0.189***	0.188***	0.187***	0.187***	0.0286	0.0304	0.0315	0.0314
	(0.0115)	(0.0115)	(0.0115)	(0.0115)	(0.0254)	(0.0254)	(0.0254)	(0.0254)
log(% mountains)	0.0571***	0.0556***	0.0542***	0.0540***	0.0870***	0.0854***	0.0840***	0.0842***
	(0.0206)	(0.0207)	(0.0207)	(0.0207)	(0.0211)	(0.0211)	(0.0211)	(0.0212)
1(Noncontiguous state)	-0.503***	-0.501***	-0.500***	-0.500***	-0.384***	-0.385***	-0.385***	-0.385***
	(0.0684)	(0.0683)	(0.0683)	(0.0683)	(0.0701)	(0.0701)	(0.0701)	(0.0701)
1(Oil producer)	-0.0376*	-0.0378*	-0.0379*	-0.0379*	-0.0445**	-0.0448**	-0.0449**	-0.0449**
	(0.0202)	(0.0202)	(0.0202)	(0.0202)	(0.0203)	(0.0203)	(0.0203)	(0.0203)
1(New State)	0.0273	0.0274	0.0274	0.0274	0.0413*	0.0413*	0.0412*	0.0412*
	(0.0213)	(0.0213)	(0.0213)	(0.0213)	(0.0219)	(0.0219)	(0.0219)	(0.0219)
1(Instability)	0.0999***	0.100***	0.101***	0.101***	0.0983***	0.0986***	0.0988***	0.0988***
	(0.00993)	(0.00993)	(0.00993)	(0.00993)	(0.00997)	(0.00997)	(0.00997)	(0.00997)
PolityIV	0.000156	7.16e-05	2.22e-05	1.45e-05	-0.000504	-0.000533	-0.000542	-0.000540
	(0.000832)	(0.000833)	(0.000834)	(0.000834)	(0.000878)	(0.000878)	(0.000878)	(0.000878)
1(Anocracy)	0.0701***	0.0698***	0.0697***	0.0697***	0.0724***	0.0723***	0.0723***	0.0722***
	(0.00964)	(0.00964)	(0.00963)	(0.00963)	(0.00970)	(0.00970)	(0.00970)	(0.00970)
Constant	1.070***	1.067***	1.064***	1.063***	0.293*	0.303**	0.309**	0.308**
	(0.0941)	(0.0941)	(0.0941)	(0.0941)	(0.150)	(0.150)	(0.150)	(0.150)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.525	0.526	0.526	0.526	0.532	0.533	0.533	0.533

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table F3. Determinants of Civil War Incidence Controling for Frequency of Extreme Heat Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
Extreme Heat$_t$	0.0199	0.0165	0.0190	0.0181	0.00911	0.00650	0.00890	0.00819
	(0.0309)	(0.0311)	(0.0311)	(0.0311)	(0.0310)	(0.0312)	(0.0312)	(0.0312)
Extreme Heat$_{t-1}$	--	0.0297	0.0235	0.0251	--	0.0236	0.0178	0.0193
		(0.0317)	(0.0319)	(0.0319)		(0.0318)	(0.0320)	(0.0320)
Extreme Heat$_{t-2}$	--	--	**0.0557***	0.0515	--	--	0.0515	0.0481
			(0.0327)	(0.0330)			(0.0328)	(0.0331)
Extreme Heat$_{t-3}$	--	--	--	0.0309	--	--	--	0.0262
				(0.0333)				(0.0334)
GDP/capita, lagged	-0.00277*	-0.00284*	-0.00295*	-0.00303*	-0.0136***	-0.0136***	-0.0136***	-0.0136***
	(0.00163)	(0.00163)	(0.00164)	(0.00164)	(0.00224)	(0.00224)	(0.00224)	(0.00224)
log(Population Density)	0.191***	0.190***	0.190***	0.190***	0.0250	0.0256	0.0265	0.0271
	(0.0115)	(0.0115)	(0.0115)	(0.0115)	(0.0253)	(0.0253)	(0.0253)	(0.0254)
log(% mountains)	0.0579***	0.0558***	0.0519**	0.0499**	0.0889***	0.0871***	0.0832***	0.0813***
	(0.0208)	(0.0209)	(0.0210)	(0.0212)	(0.0213)	(0.0214)	(0.0215)	(0.0217)
1(Noncontiguous state)	-0.502***	-0.498***	-0.491***	-0.488***	-0.382***	-0.379***	-0.373***	-0.372***
	(0.0686)	(0.0687)	(0.0688)	(0.0689)	(0.0703)	(0.0704)	(0.0705)	(0.0705)
1(Oil producer)	-0.0375*	-0.0375*	-0.0373*	-0.0369*	-0.0444**	-0.0444**	-0.0442**	-0.0440**
	(0.0202)	(0.0202)	(0.0202)	(0.0202)	(0.0203)	(0.0203)	(0.0203)	(0.0203)
1(New State)	0.0270	0.0269	0.0269	0.0268	0.0412*	0.0411*	0.0408*	0.0407*
	(0.0213)	(0.0213)	(0.0213)	(0.0213)	(0.0219)	(0.0219)	(0.0219)	(0.0219)
1(Instability)	0.0996***	0.0996***	0.0999***	0.1000***	0.0981***	0.0981***	0.0983***	0.0984***
	(0.00994)	(0.00994)	(0.00994)	(0.00994)	(0.00997)	(0.00997)	(0.00997)	(0.00997)
PolityIV	0.000294	0.000279	0.000246	0.000236	-0.000440	-0.000442	-0.000457	-0.000456
	(0.000831)	(0.000831)	(0.000831)	(0.000831)	(0.000877)	(0.000877)	(0.000877)	(0.000877)
1(Anocracy)	0.0705***	0.0705***	0.0704***	0.0704***	0.0728***	0.0727***	0.0727***	0.0727***
	(0.00964)	(0.00964)	(0.00964)	(0.00964)	(0.00970)	(0.00970)	(0.00970)	(0.00970)
Constant	1.072***	1.069***	1.062***	1.059***	0.273*	0.274*	0.274*	0.276*
	(0.0942)	(0.0943)	(0.0944)	(0.0944)	(0.150)	(0.150)	(0.150)	(0.150)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.525	0.525	0.525	0.525	0.532	0.532	0.532	0.532

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table F4. Determinants of Civil War Incidence Controling for Frequency of Epidemic Outbreaks, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Epidemic_t$	$\boxed{\textbf{0.0147*}}$	0.0118	0.0107	0.0105	$\boxed{\textbf{0.0176*}}$	0.0150	0.0141	0.0140
	(0.00870)	(0.00897)	(0.00901)	(0.00902)	(0.00903)	(0.00922)	(0.00925)	(0.00926)
$Epidemic_{t-1}$	--	0.0130	0.0102	0.00998	--	0.0137	0.0115	0.0113
		(0.00986)	(0.0101)	(0.0101)		(0.0101)	(0.0102)	(0.0103)
$Epidemic_{t-2}$	--	--	0.0156	0.0149	--	--	0.0144	0.0140
			(0.0109)	(0.0111)			(0.0112)	(0.0113)
$Epidemic_{t-3}$	--	--	--	0.00596	--	--	--	0.00287
				(0.0119)				(0.0121)
GDP/capita, lagged	-0.00261	-0.00256	-0.00251	-0.00249	-0.0133***	-0.0132***	-0.0131***	-0.0131***
	(0.00163)	(0.00163)	(0.00163)	(0.00163)	(0.00224)	(0.00224)	(0.00224)	(0.00224)
log(Population Density)	0.186***	0.184***	0.181***	0.180***	0.0213	0.0193	0.0181	0.0179
	(0.0118)	(0.0119)	(0.0121)	(0.0122)	(0.0254)	(0.0254)	(0.0254)	(0.0254)
log(% mountains)	0.0583***	0.0575***	0.0567***	0.0564***	0.0879***	0.0870***	0.0861***	0.0859***
	(0.0206)	(0.0207)	(0.0207)	(0.0207)	(0.0211)	(0.0211)	(0.0211)	(0.0211)
1(Noncontiguous state)	-0.505***	-0.505***	-0.505***	-0.505***	-0.383***	-0.383***	-0.384***	-0.385***
	(0.0684)	(0.0684)	(0.0684)	(0.0684)	(0.0701)	(0.0701)	(0.0701)	(0.0701)
1(Oil producer)	-0.0369*	-0.0363*	-0.0356*	-0.0355*	-0.0444**	-0.0440**	-0.0436**	-0.0435**
	(0.0202)	(0.0202)	(0.0202)	(0.0202)	(0.0203)	(0.0203)	(0.0203)	(0.0203)
1(New State)	0.0278	0.0282	0.0285	0.0286	0.0418*	0.0421*	0.0421*	0.0421*
	(0.0213)	(0.0213)	(0.0213)	(0.0213)	(0.0219)	(0.0219)	(0.0219)	(0.0219)
1(Instability)	0.0996***	0.0999***	0.0999***	0.0999***	0.0978***	0.0980***	0.0981***	0.0981***
	(0.00994)	(0.00994)	(0.00994)	(0.00994)	(0.00997)	(0.00997)	(0.00997)	(0.00997)
PolityIV	0.000265	0.000238	0.000237	0.000236	-0.000402	-0.000394	-0.000364	-0.000359
	(0.000831)	(0.000831)	(0.000831)	(0.000831)	(0.000877)	(0.000877)	(0.000877)	(0.000878)
1(Anocracy)	0.0697***	0.0692***	0.0686***	0.0686***	0.0721***	0.0717***	0.0713***	0.0713***
	(0.00965)	(0.00966)	(0.00967)	(0.00967)	(0.00971)	(0.00971)	(0.00971)	(0.00971)
Constant	1.060***	1.052***	1.044***	1.042***	0.261*	0.255*	0.253*	0.252*
	(0.0945)	(0.0947)	(0.0948)	(0.0950)	(0.150)	(0.150)	(0.150)	(0.150)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.525	0.525	0.525	0.525	0.532	0.532	0.533	0.533

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table F5. Determinants of Civil War Incidence Controling for Frequency of Flood Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Flood_t$	**0.0230*** **	**0.0187*** **	**0.0165*** **	**0.0144*** **	**0.0192*** **	**0.0159*** **	**0.0141*** **	**0.0124** **
	(0.00497)	(0.00512)	(0.00518)	(0.00523)	(0.00504)	(0.00517)	(0.00523)	(0.00527)
$Flood_{t-1}$	--	**0.0184*** **	**0.0152*** **	**0.0129** **	--	**0.0151*** **	**0.0124** **	**0.0104* **
		(0.00530)	(0.00543)	(0.00549)		(0.00535)	(0.00548)	(0.00553)
$Flood_{t-2}$	--	--	**0.0148*** **	**0.0118** **	--	--	**0.0128** **	**0.0102* **
			(0.00557)	(0.00566)			(0.00561)	(0.00570)
$Flood_{t-3}$	--	--	--	**0.0163*** **	--	--	--	**0.0151*** **
				(0.00578)				(0.00582)
GDP/capita, lagged	-0.00325**	-0.00360**	-0.00379**	-0.00392**	-0.0133***	-0.0132***	-0.0131***	-0.0130***
	(0.00163)	(0.00163)	(0.00163)	(0.00163)	(0.00223)	(0.00223)	(0.00223)	(0.00223)
log(Population Density)	0.178***	0.171***	0.166***	0.162***	0.0245	0.0249	0.0251	0.0250
	(0.0118)	(0.0120)	(0.0121)	(0.0122)	(0.0253)	(0.0253)	(0.0253)	(0.0252)
log(% mountains)	0.0470**	0.0396*	0.0351*	0.0315	0.0773***	0.0701***	0.0654***	0.0611***
	(0.0208)	(0.0209)	(0.0209)	(0.0210)	(0.0213)	(0.0214)	(0.0215)	(0.0216)
1(Noncontiguous state)	-0.492***	-0.486***	-0.482***	-0.480***	-0.379***	-0.378***	-0.378***	-0.378***
	(0.0683)	(0.0683)	(0.0683)	(0.0682)	(0.0701)	(0.0700)	(0.0700)	(0.0700)
1(Oil producer)	-0.0360*	-0.0347*	-0.0334*	-0.0327	-0.0435**	-0.0427**	-0.0417**	-0.0412**
	(0.0201)	(0.0201)	(0.0201)	(0.0201)	(0.0203)	(0.0203)	(0.0203)	(0.0203)
1(New State)	0.0259	0.0259	0.0259	0.0257	0.0387*	0.0380*	0.0373*	0.0366*
	(0.0212)	(0.0212)	(0.0212)	(0.0212)	(0.0219)	(0.0219)	(0.0219)	(0.0219)
1(Instability)	0.0994***	0.0990***	0.0994***	0.0998***	0.0978***	0.0974***	0.0976***	0.0978***
	(0.00992)	(0.00991)	(0.00991)	(0.00990)	(0.00996)	(0.00996)	(0.00995)	(0.00995)
PolityIV	0.000132	7.83e-05	4.17e-05	3.15e-05	-0.000436	-0.000399	-0.000375	-0.000329
	(0.000830)	(0.000830)	(0.000829)	(0.000829)	(0.000876)	(0.000876)	(0.000876)	(0.000875)
1(Anocracy)	0.0721***	0.0733***	0.0740***	0.0744***	0.0742***	0.0754***	0.0761***	0.0766***
	(0.00963)	(0.00963)	(0.00963)	(0.00962)	(0.00970)	(0.00970)	(0.00970)	(0.00970)
Constant	1.024***	0.997***	0.980***	0.963***	0.280*	0.286*	0.290*	0.293**
	(0.0946)	(0.0948)	(0.0950)	(0.0951)	(0.150)	(0.150)	(0.150)	(0.150)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.526	0.527	0.528	0.529	0.533	0.534	0.534	0.535

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table F6. Determinants of Civil War Incidence Controling for Frequency of Storm Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Storm_t$	$\boxed{\textbf{0.00815**}}$	0.00518	0.00417	0.00349	$\boxed{\textbf{0.00619*}}$	0.00385	0.00312	0.00278
	(0.00372)	(0.00442)	(0.00454)	(0.00469)	(0.00373)	(0.00444)	(0.00456)	(0.00471)
$Storm_{t-1}$	--	0.00560	0.00377	0.00341	--	0.00440	0.00307	0.00290
		(0.00450)	(0.00488)	(0.00492)		(0.00452)	(0.00490)	(0.00494)
$Storm_{t-2}$	--	--	0.00457	0.00365	--	--	0.00331	0.00285
			(0.00473)	(0.00499)			(0.00474)	(0.00501)
$Storm_{t-3}$	--	--	--	0.00288	--	--	--	0.00144
				(0.00500)				(0.00503)
GDP/capita, lagged	-0.00331**	-0.00349**	-0.00359**	-0.00364**	-0.0139***	-0.0140***	-0.0140***	-0.0140***
	(0.00165)	(0.00166)	(0.00166)	(0.00166)	(0.00224)	(0.00225)	(0.00225)	(0.00225)
log(Population Density)	0.188***	0.187***	0.187***	0.186***	0.0253	0.0253	0.0254	0.0254
	(0.0115)	(0.0116)	(0.0116)	(0.0116)	(0.0253)	(0.0253)	(0.0253)	(0.0253)
log(% mountains)	0.0452**	0.0410*	0.0387*	0.0378*	0.0784***	0.0750***	0.0733***	0.0727***
	(0.0217)	(0.0219)	(0.0220)	(0.0221)	(0.0221)	(0.0224)	(0.0225)	(0.0226)
1(Noncontiguous state)	-0.503***	-0.503***	-0.502***	-0.503***	-0.383***	-0.383***	-0.383***	-0.384***
	(0.0684)	(0.0684)	(0.0684)	(0.0684)	(0.0701)	(0.0701)	(0.0701)	(0.0702)
1(Oil producer)	-0.0361*	-0.0358*	-0.0356*	-0.0354*	-0.0433**	-0.0431**	-0.0430**	-0.0430**
	(0.0202)	(0.0202)	(0.0202)	(0.0202)	(0.0203)	(0.0203)	(0.0203)	(0.0203)
1(New State)	0.0268	0.0268	0.0268	0.0267	0.0409*	0.0410*	0.0410*	0.0409*
	(0.0213)	(0.0213)	(0.0213)	(0.0213)	(0.0219)	(0.0219)	(0.0219)	(0.0219)
1(Instability)	0.0993***	0.0993***	0.0994***	0.0994***	0.0979***	0.0979***	0.0979***	0.0979***
	(0.00994)	(0.00994)	(0.00994)	(0.00994)	(0.00997)	(0.00997)	(0.00997)	(0.00997)
PolityIV	0.000291	0.000280	0.000276	0.000278	-0.000415	-0.000410	-0.000403	-0.000397
	(0.000831)	(0.000831)	(0.000831)	(0.000831)	(0.000877)	(0.000877)	(0.000877)	(0.000878)
1(Anocracy)	0.0711***	0.0712***	0.0714***	0.0715***	0.0733***	0.0734***	0.0735***	0.0736***
	(0.00964)	(0.00964)	(0.00964)	(0.00964)	(0.00970)	(0.00971)	(0.00971)	(0.00971)
Constant	1.065***	1.062***	1.060***	1.060***	0.277*	0.278*	0.279*	0.279*
	(0.0942)	(0.0942)	(0.0942)	(0.0942)	(0.150)	(0.150)	(0.150)	(0.150)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.525	0.525	0.525	0.525	0.532	0.532	0.532	0.532

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table F7. Determinants of Civil War Incidence Controling for Frequency of Wildfire Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Wildfire_t$	0.0171	0.0163	0.0158	0.0153	0.0101	0.0106	0.0115	0.0120
	(0.0179)	(0.0183)	(0.0186)	(0.0187)	(0.0181)	(0.0184)	(0.0187)	(0.0189)
$Wildfire_{t-1}$	--	0.00415	0.00387	0.00336	--	-0.00295	-0.00235	-0.00186
		(0.0193)	(0.0195)	(0.0196)		(0.0195)	(0.0196)	(0.0197)
$Wildfire_{t-2}$	--	--	0.00262	0.00230	--	--	-0.00574	-0.00544
			(0.0211)	(0.0212)			(0.0213)	(0.0213)
$Wildfire_{t-3}$	--	--	--	0.00469	--	--	--	-0.00457
				(0.0224)				(0.0225)
GDP/capita, lagged	-0.00292*	-0.00295*	-0.00297*	-0.00299*	-0.0136***	-0.0136***	-0.0136***	-0.0136***
	(0.00164)	(0.00165)	(0.00166)	(0.00166)	(0.00224)	(0.00224)	(0.00224)	(0.00224)
log(Population Density)	0.190***	0.190***	0.190***	0.190***	0.0253	0.0252	0.0251	0.0250
	(0.0115)	(0.0115)	(0.0115)	(0.0115)	(0.0253)	(0.0253)	(0.0254)	(0.0254)
log(% mountains)	0.0579***	0.0576***	0.0575***	0.0573***	0.0886***	0.0888***	0.0891***	0.0893***
	(0.0207)	(0.0208)	(0.0208)	(0.0208)	(0.0212)	(0.0212)	(0.0213)	(0.0213)
1(Noncontiguous state)	-0.505***	-0.505***	-0.505***	-0.505***	-0.384***	-0.383***	-0.383***	-0.383***
	(0.0684)	(0.0684)	(0.0684)	(0.0684)	(0.0702)	(0.0702)	(0.0702)	(0.0702)
1(Oil producer)	-0.0371*	-0.0370*	-0.0370*	-0.0369*	-0.0442**	-0.0442**	-0.0443**	-0.0444**
	(0.0202)	(0.0202)	(0.0202)	(0.0202)	(0.0203)	(0.0203)	(0.0203)	(0.0203)
1(New State)	0.0270	0.0270	0.0270	0.0269	0.0412*	0.0412*	0.0412*	0.0413*
	(0.0213)	(0.0213)	(0.0213)	(0.0213)	(0.0219)	(0.0219)	(0.0219)	(0.0219)
1(Instability)	0.0997***	0.0997***	0.0998***	0.0998***	0.0981***	0.0981***	0.0981***	0.0981***
	(0.00994)	(0.00994)	(0.00994)	(0.00994)	(0.00997)	(0.00997)	(0.00997)	(0.00998)
PolityIV	0.000256	0.000249	0.000246	0.000239	-0.000454	-0.000451	-0.000447	-0.000442
	(0.000833)	(0.000833)	(0.000834)	(0.000834)	(0.000878)	(0.000878)	(0.000878)	(0.000879)
1(Anocracy)	0.0706***	0.0706***	0.0706***	0.0707***	0.0728***	0.0728***	0.0728***	0.0728***
	(0.00964)	(0.00964)	(0.00964)	(0.00964)	(0.00970)	(0.00970)	(0.00970)	(0.00971)
Constant	1.075***	1.075***	1.074***	1.074***	0.277*	0.276*	0.275*	0.274*
	(0.0941)	(0.0941)	(0.0941)	(0.0941)	(0.150)	(0.150)	(0.150)	(0.150)
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.525	0.525	0.525	0.525	0.532	0.532	0.532	0.532

Note: All regressions are fixed effects linear probability models. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table F8. Determinants of Civil War Incidence Controling for Frequency of All Disaster Events, 1945-1999 (n=6278)

Variables	P1	P2	P3	P4	P5	P6	P7	P8
$Drought_t$	0.00992	0.00646	0.00574	0.00436	0.00531	0.00406	0.00345	0.00247
	(0.0117)	(0.0122)	(0.0123)	(0.0123)	(0.0119)	(0.0124)	(0.0124)	(0.0125)
$Drought_{t-1}$	--	0.0125	0.0124	0.0127	--	0.00430	0.00605	0.00630
		(0.0125)	(0.0131)	(0.0131)		(0.0127)	(0.0132)	(0.0133)
$Drought_{t-2}$	--	--	0.00274	0.000902	--	--	-0.00425	-0.00413
			(0.0128)	(0.0134)			(0.0130)	(0.0135)
$Drought_{t-3}$	--	--	--	0.00647	--	--	--	-0.000422
				(0.0131)				(0.0133)
Extreme $Cold_t$	**0.0603****	**0.0507****	**0.0442***	**0.0453***	**0.0459***	0.0395	0.0342	0.0354
	(0.0250)	(0.0256)	(0.0258)	(0.0259)	(0.0252)	(0.0257)	(0.0260)	(0.0260)
Extreme $Cold_{t-1}$	--	0.0318	0.0271	0.0258	--	0.0219	0.0187	0.0181
		(0.0264)	(0.0268)	(0.0270)		(0.0266)	(0.0269)	(0.0271)
Extreme $Cold_{t-2}$	--	--	0.0272	0.0282	--	--	0.0215	0.0240
			(0.0275)	(0.0277)			(0.0276)	(0.0279)
Extreme $Cold_{t-3}$	--	--	--	-0.00890	--	--	--	-0.0173
				(0.0299)				(0.0300)
Extreme $Heat_t$	0.00507	0.00196	-0.00183	-0.00186	-0.00227	-0.00472	-0.00732	-0.00725
	(0.0310)	(0.0315)	(0.0318)	(0.0318)	(0.0311)	(0.0316)	(0.0319)	(0.0320)
Extreme $Heat_{t-1}$	--	0.0152	0.0116	0.00497	--	0.0133	0.0103	0.00452
		(0.0318)	(0.0322)	(0.0325)		(0.0319)	(0.0324)	(0.0326)
Extreme $Heat_{t-2}$	--	--	0.0348	0.0338	--	--	0.0365	0.0364
			(0.0335)	(0.0339)			(0.0336)	(0.0341)
Extreme $Heat_{t-3}$	--	--	--	0.00500	--	--	--	0.00809
				(0.0342)				(0.0343)
$Epidemic_t$	0.0103	0.00655	0.00592	0.00478	0.0150*	0.0117	0.0111	0.0104
	(0.00877)	(0.00903)	(0.00906)	(0.00908)	(0.00908)	(0.00927)	(0.00930)	(0.00932)
$Epidemic_{t-1}$	--	0.00772	0.00499	0.00540	--	0.0101	0.00790	0.00810
		(0.00991)	(0.0101)	(0.0101)		(0.0101)	(0.0103)	(0.0103)
$Epidemic_{t-2}$	--	--	0.00780	0.00688	--	--	0.00850	0.00786
			(0.0110)	(0.0111)			(0.0113)	(0.0114)
$Epidemic_{t-3}$	--	--	--	-0.00493	--	--	--	-0.00552
				(0.0120)				(0.0122)
$Flood_t$	**0.0203*****	**0.0168*****	**0.0151*****	**0.0141*****	**0.0174*****	**0.0147*****	**0.0134****	**0.0126****
	(0.00519)	(0.00534)	(0.00539)	(0.00546)	(0.00524)	(0.00538)	(0.00543)	(0.00549)
$Flood_{t-1}$	--	**0.0168*****	**0.0143****	**0.0131****	--	**0.0141****	**0.0120****	**0.0110***
		(0.00559)	(0.00570)	(0.00573)		(0.00563)	(0.00574)	(0.00577)
$Flood_{t-2}$	--	--	**0.0150****	**0.0133****	--	--	**0.0135****	**0.0122****
			(0.00584)	(0.00592)			(0.00588)	(0.00596)
$Flood_{t-3}$	--	--	--	**0.0170*****	--	--	--	**0.0162*****
				(0.00600)				(0.00604)
$Storm_t$	0.00307	-0.000148	-0.00285	-0.00168	0.00228	-0.000233	-0.00265	-0.00139
	(0.00396)	(0.00458)	(0.00476)	(0.00488)	(0.00398)	(0.00460)	(0.00478)	(0.00490)
$Storm_{t-1}$	--	0.000756	-0.000148	-0.00169	--	0.000844	0.000208	-0.00127
		(0.00469)	(0.00503)	(0.00515)		(0.00471)	(0.00505)	(0.00518)
$Storm_{t-2}$	--	--	1.08e-05	-0.000373	--	--	-4.52e-05	-6.19e-05
			(0.00488)	(0.00514)			(0.00490)	(0.00517)
$Storm_{t-3}$	--	--	--	-0.00290	--	--	--	-0.00328
				(0.00513)				(0.00515)
$Wildfire_t$	0.00208	-0.00520	-0.00516	-0.00749	-0.000657	-0.00560	-0.00449	-0.00539
	(0.0184)	(0.0191)	(0.0193)	(0.0195)	(0.0186)	(0.0192)	(0.0194)	(0.0196)
$Wildfire_{t-1}$	--	-0.0126	-0.0159	-0.0154	--	-0.0152	-0.0172	-0.0161
		(0.0198)	(0.0201)	(0.0202)		(0.0199)	(0.0202)	(0.0203)
$Wildfire_{t-2}$	--	--	-0.00943	-0.0124	--	--	-0.0139	-0.0155
			(0.0214)	(0.0216)			(0.0216)	(0.0218)
$Wildfire_{t-3}$	--	--	--	-0.00395	--	--	--	-0.0111
				(0.0227)				(0.0228)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.527	0.528	0.529	0.530	0.534	0.534	0.535	0.536

Note: All regressions are fixed effects linear probability models that include the full set of control variables (same as in Tables). Standard errors in parentheses. Control variable estimates are not displayed. *** p<0.01, ** p<0.05, * p<0.1.

Table F9. Determinants of Civil War Incidence : Significant Coefficients from Individual Event Fixed Effects Linear Probabilty Models, 1945-1999 (n=6278)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
Extreme Cold$_t$	0.0578** to 0.0696***	P1,P2,P3,P4	0.0442* to 0.0523**	P5,P6,P7,P8
Extreme Cold$_{t-2}$	0.0458* to 0.0466*	P3,P4	--	--
Extreme Heat$_{t-2}$	0.0557*	P3	--	--
Epidemic$_t$	0.0147*	P1	0.0176*	P5
Flood$_t$	0.0144*** to 0.0230***	P1,P2,P3,P4	0.0124** to 0.0192***	P5,P6,P7,P8
Flood$_{t-1}$	0.0129** to 0.0152***	P2,P3,P4	0.0104* to 0.0124**	P6,P7,P8
Flood$_{t-2}$	0.0118** to 0.0148***	P3,P4	0.0102* to 0.0128**	P7,P8
Flood$_{t-3}$	0.0163***	P4	0.0151***	P8
Storm$_t$	0.00815**	P1	0.00619*	P5
Control Variables	Yes		Yes	
Country Fixed Effects	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix F Tables F1 through F7. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table F10. Determinants of Civil War Incidence : Significant Coefficients from All Events Fixed Effects Linear Probabilty Models, 1945-1999 (n=6278)

Variables	Significant Coefficients	Models	Significant Coefficients	Models
Extreme Cold$_t$	0.0442* to 0.0603**	P1,P2,P3,P4	0.0459*	P5
Flood$_t$	0.0141*** to 0.0203***	P1,P2,P3,P4	0.0126** to 0.0174***	P5,P6,P7,P8
Flood$_{t-1}$	0.0131** to 0.0168***	P2,P3,P4	0.0110* to 0.0141**	P6,P7,P8
Flood$_{t-2}$	0.0133** to 0.0150***	P3,P4	0.0122* to 0.0135**	P7,P8
Flood$_{t-3}$	0.0170***	P4	0.0162***	P8
Control Variables	Yes		Yes	
Country Fixed Effects	Yes		Yes	
Time Fixed Effects	No		Yes	

Note: Summary of selected coefficients from Appendix F Table F8. Only significant coefficients are presented. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

G. Civil War Duration Models

In appendix G I estimate civil war duration using Cox proportional hazard model (column 1 in each table), Exponential survival model (column 2 in each table), Weibull survival model (column 3 in each table), Gompertz survival model (column 4 in each table), Prentice-Gloeckler (1978) discrete time proportional hazards model and a panel logit model. . Table G1 provides estimates for drought events; G2 for extreme cold temperature events; G3 for extreme heat events; G4 for epidemic outbreaks; G5 for flood events; G6 for storm events; and G7 for wildfire events. Table G8 provides estimates of all the aforementioned models for all disaster events jointly.

Table G1. Determinants of Civil War Duration Controlling for Frequency of Drought Events, 1945-1999 (n=1102)

Variables	Cox	Exponential	Weibull	Gompertz	Discrete Time Proportional Hazards	Logit
Drought	**-0.117***	**-1.377****	**-1.485****	**-1.415****	**-1.400****	**-1.460****
	(0.0616)	(0.591)	(0.593)	(0.593)	(0.594)	(0.603)
1(Coup/revolution)	1.190***	1.136***	1.351***	1.191***	1.415***	1.467***
	(0.286)	(0.274)	(0.289)	(0.282)	(0.344)	(0.371)
1(Eastern Europe)	1.088***	0.987***	1.283***	1.075***	1.055***	1.190***
	(0.354)	(0.338)	(0.362)	(0.353)	(0.371)	(0.409)
1(Not contiguous)	0.528*	0.378	0.510*	0.432	0.399	0.425
	(0.290)	(0.294)	(0.302)	(0.302)	(0.319)	(0.330)
1(Sons of the soil)	-1.129***	-1.129***	-1.314***	-1.226***	-1.200***	-1.238***
	(0.385)	(0.371)	(0.383)	(0.390)	(0.384)	(0.397)
1(Contraband)	-1.335***	-1.291***	-1.386***	-1.353***	-1.349***	-1.388***
	(0.462)	(0.445)	(0.448)	(0.452)	(0.464)	(0.469)
GDP/capita, lagged	-0.00401	-0.00479	-0.0231	-0.0163	0.00877	-0.00121
	(0.00369)	(0.0509)	(0.0508)	(0.0517)	(0.0580)	(0.0609)
log(Population Density$_t$)	0.00140	-0.0590	-0.0634	-0.0587	-0.0746	-0.0730
	(0.0104)	(0.0924)	(0.0933)	(0.0927)	(0.0989)	(0.105)
Democracy (–10 to 10, lagged)	0.00467**	0.0252	0.0288	0.0265	0.0266	0.0299
	(0.00214)	(0.0177)	(0.0180)	(0.0178)	(0.0185)	(0.0197)
Constant	--	-2.420***	-3.006***	-2.509***	-2.393***	-2.349***
		(0.379)	(0.453)	(0.394)	(0.399)	(0.423)

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table G2. Determinants of Civil War Duration Controlling for Frequency of Extreme Cold Events, 1945-1999 (n=1102)

Variables	Cox	Exponential	Weibull	Gompertz	Discrete Time Proportional Hazards	Logit
Extreme Cold	-0.00989	-0.0206	-0.883	-0.937	-1.110	-1.119
	(0.0491)	(0.0516)	(0.919)	(0.918)	(0.946)	(0.983)
1(Coup/revolution)	1.218***	1.187***	1.437***	1.277***	1.559***	1.638***
	(0.286)	(0.299)	(0.288)	(0.280)	(0.336)	(0.371)
1(Eastern Europe)	1.121***	1.180***	1.461***	1.262***	1.267***	1.415***
	(0.354)	(0.382)	(0.360)	(0.352)	(0.385)	(0.431)
1(Not contiguous)	0.539*	0.406	0.575*	0.490	0.439	0.468
	(0.293)	(0.296)	(0.304)	(0.303)	(0.338)	(0.351)
1(Sons of the soil)	-1.216***	-1.170***	-1.387***	-1.290***	-1.312***	-1.350***
	(0.390)	(0.380)	(0.383)	(0.386)	(0.391)	(0.411)
1(Contraband)	-1.254***	-1.056**	-1.252***	-1.214***	-1.266***	-1.305***
	(0.460)	(0.445)	(0.447)	(0.450)	(0.474)	(0.486)
GDP/capita, lagged	-0.00193	-0.0727	-0.00156	0.00584	0.0355	0.0296
	(0.00352)	(0.0903)	(0.0507)	(0.0517)	(0.0626)	(0.0658)
log(Population Density$_t$)	-9.09e-05	0.135	-0.0596	-0.0583	-0.0878	-0.0798
	(0.0103)	(0.139)	(0.0926)	(0.0924)	(0.103)	(0.109)
Democracy (–10 to 10, lagged)	0.00470**	0.0139	0.0339*	0.0316*	0.0338*	0.0366*
	(0.00215)	(0.0179)	(0.0182)	(0.0180)	(0.0190)	(0.0205)
Constant	--	-2.658**	-3.102***	-2.654***	-2.571***	-2.554***
		(1.318)	(0.455)	(0.396)	(0.416)	(0.439)

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table G3. Determinants of Civil War Duration Controlling for Frequency of Extreme Heat Events, 1945-1999 (n=1102)

Variables	Cox	Exponential	Weibull	Gompertz	Discrete Time Proportional Hazards	Logit
Extreme Heat	-17.60	-13.63	-12.82	-14.03	-16.03	-15.63
	(4.175e+07)	(861.9)	(586.6)	(1,063)	(1,670)	(2,043)
Coup/revolution	1.203***	1.238***	1.440***	1.278***	1.406***	1.637***
	(0.285)	(0.271)	(0.288)	(0.280)	(0.273)	(0.370)
Eastern Europe	1.133***	1.167***	1.445***	1.228***	1.317***	1.369***
	(0.354)	(0.335)	(0.361)	(0.351)	(0.337)	(0.428)
Not contiguous	0.531*	0.460	0.586*	0.498	0.520*	0.482
	(0.291)	(0.295)	(0.304)	(0.303)	(0.295)	(0.349)
Sons of the soil	-1.221***	-1.226***	-1.392***	-1.287***	-1.283***	-1.349***
	(0.390)	(0.371)	(0.383)	(0.387)	(0.371)	(0.410)
Contraband	-1.241***	-1.169***	-1.242***	-1.204***	-1.180***	-1.303***
	(0.459)	(0.445)	(0.447)	(0.449)	(0.445)	(0.485)
GDP/capita, lagged	-0.00244	0.00689	-0.00750	-0.000112	0.0129	0.0216
	(0.00341)	(0.0507)	(0.0504)	(0.0515)	(0.0505)	(0.0649)
log(Population Density$_t$)	-4.09e-05	-0.0551	-0.0573	-0.0545	-0.0592	-0.0769
	(0.0102)	(0.0915)	(0.0921)	(0.0916)	(0.0920)	(0.109)
Democracy (–10 to 10, lagged)	0.00487**	0.0306*	0.0340*	0.0314*	0.0312*	0.0364*
	(0.00215)	(0.0179)	(0.0182)	(0.0180)	(0.0179)	(0.0204)
Constant	--	-2.569***	-3.093***	-2.631***	-2.561***	-2.534***
		(0.378)	(0.454)	(0.393)	(0.380)	(0.435)

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table G4. Determinants of Civil War Duration Controlling for Frequency of Epidemic Events, 1945-1999 (n=1102)

Variables	Cox	Exponential	Weibull	Gompertz	Discrete Time Proportional Hazards	Logit
Epidemic	0.0161	0.105	0.0781	0.0955	0.103	0.131
	(0.0172)	(0.176)	(0.179)	(0.177)	(0.179)	(0.190)
1(Coup/revolution)	1.225***	1.271***	1.470***	1.308***	1.586***	1.668***
	(0.286)	(0.273)	(0.289)	(0.281)	(0.339)	(0.372)
1(Eastern Europe)	1.119***	1.146***	1.424***	1.205***	1.181***	1.341***
	(0.354)	(0.336)	(0.362)	(0.352)	(0.383)	(0.427)
1(Not contiguous)	0.558*	0.506*	0.625**	0.539*	0.510	0.539
	(0.292)	(0.297)	(0.305)	(0.304)	(0.334)	(0.348)
1(Sons of the soil)	-1.271***	-1.272***	-1.432***	-1.331***	-1.346***	-1.402***
	(0.398)	(0.375)	(0.388)	(0.392)	(0.393)	(0.413)
1(Contraband)	-1.291***	-1.204***	-1.274***	-1.238***	-1.291***	-1.338***
	(0.460)	(0.445)	(0.447)	(0.450)	(0.473)	(0.486)
GDP/capita, lagged	-0.00115	0.0131	-0.00174	0.00605	0.0298	0.0281
	(0.00358)	(0.0510)	(0.0508)	(0.0520)	(0.0607)	(0.0647)
log(Population Density$_t$)	-0.00322	-0.0665	-0.0678	-0.0654	-0.0907	-0.0911
	(0.0106)	(0.0916)	(0.0924)	(0.0918)	(0.102)	(0.109)
Democracy (–10 to 10, lagged)	0.00474**	0.0283	0.0317*	0.0290	0.0303	0.0335*
	(0.00216)	(0.0178)	(0.0181)	(0.0179)	(0.0187)	(0.0203)
Constant	--	-2.661***	-3.172***	-2.715***	-2.629***	-2.646***
		(0.387)	(0.461)	(0.400)	(0.416)	(0.445)

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table G5. Determinants of Civil War Duration Controlling for Frequency of Flood Events, 1945-1999 (n=1102)

Variables	Cox	Exponential	Weibull	Gompertz	Discrete Time Proportional Hazards	Logit
Floods	-0.00422	-0.0793	-0.111	-0.0948	-0.0766	-0.0821
	(0.0103)	(0.120)	(0.124)	(0.123)	(0.122)	(0.129)
1(Coup/revolution)	1.213***	1.224***	1.425***	1.269***	1.533***	1.604***
	(0.286)	(0.274)	(0.290)	(0.282)	(0.341)	(0.371)
1(Eastern Europe)	1.119***	1.127***	1.410***	1.202***	1.171***	1.324***
	(0.354)	(0.336)	(0.361)	(0.351)	(0.381)	(0.423)
1(Not contiguous)	0.545*	0.454	0.575*	0.497	0.461	0.487
	(0.291)	(0.297)	(0.304)	(0.304)	(0.334)	(0.346)
1(Sons of the soil)	-1.204***	-1.173***	-1.312***	-1.235***	-1.255***	-1.291***
	(0.394)	(0.383)	(0.394)	(0.396)	(0.400)	(0.419)
1(Contraband)	-1.263***	-1.180***	-1.256***	-1.226***	-1.263***	-1.298***
	(0.459)	(0.445)	(0.447)	(0.450)	(0.472)	(0.481)
GDP/capita, lagged	-0.00238	0.00742	-0.00916	-0.00197	0.0251	0.0198
	(0.00343)	(0.0509)	(0.0508)	(0.0518)	(0.0606)	(0.0639)
log(Population Density$_t$)	0.000517	-0.0490	-0.0464	-0.0463	-0.0731	-0.0668
	(0.0105)	(0.0923)	(0.0930)	(0.0925)	(0.102)	(0.109)
Democracy (–10 to 10, lagged)	0.00469**	0.0288	0.0327*	0.0299*	0.0308	0.0338*
	(0.00218)	(0.0179)	(0.0182)	(0.0180)	(0.0188)	(0.0202)
Constant	--	-2.527***	-3.047***	-2.591***	-2.504***	-2.482***
		(0.392)	(0.461)	(0.403)	(0.421)	(0.448)

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table G6. Determinants of Civil War Duration Controlling for Frequency of Storm Events, 1945-1999 (n=1102)

Variables	Cox	Exponential	Weibull	Gompertz	Discrete Time Proportional Hazards	Logit
Storms	4.49e-05	-0.0881	-0.113	-0.101	-0.0911	-0.0919
	(0.00634)	(0.108)	(0.109)	(0.110)	(0.115)	(0.116)
1(Coup/revolution)	1.219***	1.221***	1.424***	1.269***	1.525***	1.597***
	(0.286)	(0.273)	(0.289)	(0.281)	(0.340)	(0.369)
1(Eastern Europe)	1.122***	1.123***	1.412***	1.202***	1.173***	1.324***
	(0.354)	(0.335)	(0.361)	(0.351)	(0.380)	(0.421)
1(Not contiguous)	0.552*	0.443	0.564*	0.487	0.450	0.479
	(0.291)	(0.297)	(0.304)	(0.304)	(0.333)	(0.345)
1(Sons of the soil)	-1.231***	-1.174***	-1.327***	-1.244***	-1.253***	-1.291***
	(0.390)	(0.376)	(0.386)	(0.390)	(0.393)	(0.411)
1(Contraband)	-1.268***	-1.211***	-1.302***	-1.266***	-1.291***	-1.325***
	(0.462)	(0.445)	(0.448)	(0.452)	(0.471)	(0.479)
GDP/capita, lagged	-0.00222	0.00850	-0.00835	-0.00132	0.0260	0.0199
	(0.00358)	(0.0511)	(0.0511)	(0.0520)	(0.0605)	(0.0637)
log(Population Density$_t$)	-0.000745	-0.0401	-0.0351	-0.0362	-0.0637	-0.0568
	(0.0112)	(0.0937)	(0.0946)	(0.0941)	(0.103)	(0.110)
Democracy (–10 to 10, lagged)	0.00474**	0.0290	0.0333*	0.0303*	0.0309	0.0340*
	(0.00216)	(0.0179)	(0.0183)	(0.0181)	(0.0188)	(0.0202)
Constant	--	-2.501***	-3.021***	-2.565***	-2.478***	-2.453***
		(0.393)	(0.461)	(0.404)	(0.421)	(0.448)

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table G7. Determinants of Civil War Duration Controlling for Frequency of Wildfire Events, 1945-1999 (n=1102)

Variables	Cox	Exponential	Weibull	Gompertz	Discrete Time Proportional Hazards	Logit
Wildfires	0.0179	0.208	0.269	0.202	0.171	0.295
	(0.0456)	(0.462)	(0.471)	(0.464)	(0.473)	(0.574)
1(Coup/revolution)	1.218***	1.252***	1.461***	1.293***	1.560***	1.634***
	(0.286)	(0.272)	(0.289)	(0.280)	(0.337)	(0.368)
1(Eastern Europe)	1.117***	1.120***	1.401***	1.184***	1.165***	1.313***
	(0.354)	(0.340)	(0.365)	(0.356)	(0.384)	(0.426)
1(Not contiguous)	0.545*	0.484	0.609**	0.522*	0.492	0.518
	(0.292)	(0.295)	(0.304)	(0.303)	(0.330)	(0.344)
1(Sons of the soil)	-1.235***	-1.252***	-1.428***	-1.317***	-1.325***	-1.376***
	(0.391)	(0.372)	(0.386)	(0.390)	(0.389)	(0.407)
1(Contraband)	-1.271***	-1.192***	-1.269***	-1.231***	-1.275***	-1.315***
	(0.459)	(0.445)	(0.447)	(0.450)	(0.471)	(0.482)
GDP/capita, lagged	-0.00190	0.00892	-0.00572	0.00175	0.0257	0.0212
	(0.00353)	(0.0509)	(0.0506)	(0.0517)	(0.0602)	(0.0636)
log(Population Density$_t$)	-0.00112	-0.0567	-0.0586	-0.0564	-0.0813	-0.0783
	(0.0102)	(0.0912)	(0.0917)	(0.0913)	(0.101)	(0.107)
Democracy (–10 to 10, lagged)	0.00467**	0.0276	0.0309*	0.0284	0.0297	0.0328
	(0.00216)	(0.0179)	(0.0182)	(0.0180)	(0.0188)	(0.0202)
Constant	--	-2.599***	-3.133***	-2.663***	-2.575***	-2.568***
		(0.374)	(0.451)	(0.390)	(0.404)	(0.428)

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table G8. Determinants of Civil War Duration Controlling for Frequency of All Climate Change Related Events, 1945-1999 (n=1102)

Variables	Cox	Exponential	Weibull	Gompertz	Discrete Time Proportional Hazards	Logit
Drought	**-0.128****	**-1.377****	**-1.488****	**-1.412****	**-1.418****	**-1.462****
	(0.0614)	(0.591)	(0.594)	(0.593)	(0.592)	(0.606)
Extreme Cold	-22.10	-14.00	-12.98	-13.94	-15.62	-16.47
	(0)	(1,209)	(759.0)	(1,194)	(1,626)	(3,800)
Extreme Heat	-0.00755	-0.986	-0.838	-0.936	-1.127	-1.190
	(0.0534)	(0.901)	(0.893)	(0.900)	(0.924)	(0.985)
Epidemic	0.0169	0.201	0.157	0.186	0.199	0.223
	(0.0184)	(0.179)	(0.185)	(0.183)	(0.181)	(0.196)
Flood	-0.00614	-0.0309	-0.0676	-0.0463	-0.0264	-0.0285
	(0.0124)	(0.136)	(0.138)	(0.138)	(0.136)	(0.145)
Storm	0.00411	-0.0165	-0.0376	-0.0276	-0.0152	-0.0142
	(0.00689)	(0.108)	(0.108)	(0.109)	(0.108)	(0.117)
Wildfire	0.0386	0.400	0.477	0.389	0.495	0.502
	(0.0494)	(0.543)	(0.550)	(0.546)	(0.547)	(0.651)
1(Coup/revolution)	1.174***	1.111***	1.308***	1.156***	1.273***	1.476***
	(0.286)	(0.279)	(0.292)	(0.285)	(0.281)	(0.381)
1(Eastern Europe)	1.091***	1.061***	1.313***	1.134***	1.219***	1.284***
	(0.354)	(0.345)	(0.363)	(0.356)	(0.345)	(0.426)
1(Not contiguous)	0.502*	0.337	0.438	0.375	0.385	0.359
	(0.295)	(0.301)	(0.307)	(0.306)	(0.302)	(0.347)
1(Sons of the soil)	-1.146***	-1.153***	-1.283***	-1.219***	-1.213***	-1.288***
	(0.400)	(0.395)	(0.405)	(0.407)	(0.396)	(0.431)
1(Contraband)	-1.311***	-1.270***	-1.365***	-1.326***	-1.287***	-1.394***
	(0.468)	(0.447)	(0.449)	(0.452)	(0.447)	(0.480)
log(GDP/capita, lagged)	-0.00323	0.000133	-0.0225	-0.0120	0.00697	0.00901
	(0.00408)	(0.0515)	(0.0522)	(0.0528)	(0.0513)	(0.0652)
log(Population Density$_t$)	-0.000206	-0.0537	-0.0431	-0.0478	-0.0606	-0.0679
	(0.0123)	(0.0971)	(0.0981)	(0.0976)	(0.0977)	(0.113)
Democracy (–10 to 10, lagged)	0.00474**	0.0298*	0.0332*	0.0311*	0.0303*	0.0360*
	(0.00221)	(0.0180)	(0.0184)	(0.0182)	(0.0180)	(0.0204)
Constant	--	-2.412***	-2.916***	-2.464***	-2.408***	-2.343***
		(0.416)	(0.471)	(0.422)	(0.419)	(0.475)

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

APPENDIX 3

SUPPLEMENTARY INFORMATION FOR CHAPTER IV

A. Continuous Models Without And With Time-Varying Covariates

Table A1. Determinants of MARPOL legislative delay - quantity of oil spilled between 1970 and 1978, (period 1978-2009, n=129)

	Exponential	Gompertz	Lognormal	Loglogistic	Cox
Pre 1978 oil spill quantity (in 10,000s of tons)	0.1208***	0.2112***	-0.0937***	-0.1032***	0.2345***
	(0.0410)	(0.0741)	(0.0295)	(0.0308)	(0.0802)
Square of pre 1978 oil spill quantity (in 10,000s of tons)	-0.0036	-0.0066	0.0024*	0.0029*	-0.0073*
	(0.0023)	(0.0041)	(0.0014)	(0.0016)	(0.0042)
Population (in millions)	0.0014**	0.0023**	-0.0012***	-0.0010***	0.0026***
	(0.0006)	(0.0009)	(0.0004)	(0.0003)	(0.0009)
PolityIV	0.0078	0.0234	-0.0042	-0.0039	0.0228
	(0.0113)	(0.0195)	(0.0077)	(0.0077)	(0.0184)
Trade openness	0.0040***	0.0071***	-0.0027***	-0.0025***	0.0072***
	(0.0013)	(0.0019)	(0.0010)	(0.0009)	(0.0018)
GDP (in hundreds of billions of 1990$)	-0.0054	-0.0024	-0.0008	-0.0020	0.0112
	(0.0357)	(0.0587)	(0.0208)	(0.0256)	(0.0622)
Oil production (thousands of barrels)	0.0380	0.0324	0.0230	0.0250	0.0042
	(0.0374)	(0.0547)	(0.0237)	(0.0203)	(0.0513)
Oil tankers (100,000s of tons)	0.0017***	0.0029***	-0.0014***	-0.0015***	0.0037***
	(0.0002)	(0.0003)	(0.0001)	(0.0001)	(0.0005)
Average time to ratify previous IEAs (days/365)	0.0512*	0.0630*	-0.0318*	-0.0284*	0.0553
	(0.0264)	(0.0378)	(0.0187)	(0.0159)	(0.0362)
Total number of previous IEAs ratified	0.0406***	0.0599***	-0.0333***	-0.0344***	0.0647***
	(0.0076)	(0.0121)	(0.0056)	(0.0054)	(0.0131)
Land area (100,000s of sq.km)	0.0007	0.0053	-0.0009	-0.0024	0.0065
	(0.0070)	(0.0121)	(0.0036)	(0.0033)	(0.0107)
Coastline length (thousands of km)	0.0002	-0.0014	0.0005	0.0019	-0.0040
	(0.0041)	(0.0071)	(0.0030)	(0.0026)	(0.0067)
Latitude	-0.6584	-0.9621	0.5204	0.6030	-0.8868
	(0.6743)	(1.0170)	(0.4834)	(0.4508)	(0.9614)
Constant	-10.6508***	-12.7305***	9.9578***	9.9363***	
	(0.3660)	(0.5785)	(0.2406)	(0.2101)	
Shape parameter		0.000258***	-0.715***	-1.326***	
Log-likelihood	-140.0	-112.1	-94.3	-91.5	-395.4
AIC	308.0	254.2	218.6	212.9	816.8
BIC	348.1	297.1	261.5	255.8	854.0

Table A2. Determinants of MARPOL legislative delay -number of oil spill incidents between 1970-1978 (period 1978-2009, n=129)

	Exponential	Gompertz	Lognormal	Loglogistic	Cox
Pre 1978 oil spill incidents (in tens)	0.2011	0.3706	-0.2097	-0.1725	0.5488*
	(0.1987)	(0.3139)	(0.1972)	(0.2449)	(0.3223)
Square of pre 1978 oil spill incidents (in tens)	-0.0015	-0.0167	0.0006	0.0022	-0.0360
	(0.0387)	(0.0685)	(0.0271)	(0.0289)	(0.0669)
Population (in millions)	0.0015**	0.0025**	-0.0012***	-0.0011***	0.0029***
	(0.0006)	(0.0011)	(0.0003)	(0.0003)	(0.0009)
PolityIV	0.0097	0.0250	-0.0060	-0.0052	0.0244
	(0.0116)	(0.0197)	(0.0081)	(0.0081)	(0.0185)
Trade openness	0.0034**	0.0060***	-0.0024**	-0.0021**	0.0059***
	(0.0013)	(0.0019)	(0.0010)	(0.0009)	(0.0018)
GDP (in hundreds of billions of 1990$)	-0.0303	-0.0363	0.0260	0.0175	-0.0305
	(0.0471)	(0.0644)	(0.0486)	(0.0676)	(0.0634)
Oil production (thousands of barrels)	0.0254	0.0117	0.0293	0.0313	-0.0206
	(0.0390)	(0.0585)	(0.0245)	(0.0222)	(0.0538)
Oil tankers (100,000s of tons)	0.0017***	0.0029***	-0.0014***	-0.0015***	0.0037***
	(0.0002)	(0.0003)	(0.0001)	(0.0001)	(0.0006)
Average time to ratify previous IEAs (days/365)	0.0511*	0.0598	-0.0349*	-0.0286	0.0522
	(0.0279)	(0.0383)	(0.0209)	(0.0187)	(0.0362)
Total number of previous IEAs ratified	0.0420***	0.0605***	-0.0342***	-0.0349***	0.0647***
	(0.0076)	(0.0123)	(0.0056)	(0.0052)	(0.0131)
Land area (100,000s of sq.km)	0.0018	0.0054	-0.0033	-0.0040	0.0077
	(0.0075)	(0.0136)	(0.0036)	(0.0036)	(0.0112)
Coastline length (thousands of km)	0.0015	0.0015	0.0003	0.0011	-0.0016
	(0.0042)	(0.0076)	(0.0029)	(0.0027)	(0.0067)
Latitude	-0.7786	-1.1516	0.5650	0.6411	-1.0675
	(0.6613)	(0.9774)	(0.4804)	(0.4441)	(0.9168)
Constant	-10.5752***	-12.4596***	9.9492***	9.8832***	
	(0.3773)	(0.5501)	(0.2669)	(0.2405)	
Shape parameter		0.0002***	-0.6791***	-1.2816***	
Log-likelihood	-141.31	-115.28	-98.39	-96.17	-398.51
AIC	310.62	260.55	226.79	222.34	823.02
BIC	350.65	303.45	269.68	265.24	860.20

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table A3. Determinants of MARPOL legislative delay - quantity of oil spilled and oil spill incidents between 1970 and 1978 (period 1978-2009, n=129)

	Exponential	Gompertz	Lognormal	Loglogistic	Cox
Pre 1978 oil spill quantity (in 10,000s of tons)	0.2040***	0.3285***	-0.1287***	-0.1375***	0.3140***
	(0.0486)	(0.0866)	(0.0390)	(0.0388)	(0.0911)
Square of pre 1978 oil spill quantity (in 10,000s of tons)	-0.0107***	-0.0163**	0.0056**	0.0060**	-0.0138**
	(0.0037)	(0.0065)	(0.0028)	(0.0027)	(0.0068)
Pre 1978 oil spill incidents (in tens)	-0.2325	-0.1845	0.0522	0.0594	0.1450
	(0.2973)	(0.5370)	(0.2070)	(0.2113)	(0.5732)
Square of pre 1978 oil spill incidents (in tens)	0.1438*	0.1810	-0.0721	-0.0747	0.1118
	(0.0829)	(0.1497)	(0.0604)	(0.0620)	(0.1562)
Population (in millions)	0.0014**	0.0021**	-0.0011***	-0.0010***	0.0024***
	(0.0006)	(0.0009)	(0.0004)	(0.0003)	(0.0009)
PolityIV	0.0067	0.0217	-0.0038	-0.0040	0.0213
	(0.0113)	(0.0198)	(0.0076)	(0.0076)	(0.0188)
Trade openness	0.0042***	0.0075***	-0.0027***	-0.0025***	0.0072***
	(0.0013)	(0.0019)	(0.0010)	(0.0009)	(0.0019)
GDP (in hundreds of billions of 1990$)	-0.0621	-0.0855	0.0446	0.0446	-0.0805
	(0.0391)	(0.0551)	(0.0388)	(0.0540)	(0.0561)
Oil production (thousands of barrels)	0.0505	0.0425	0.0193	0.0198	-0.0019
	(0.0426)	(0.0630)	(0.0271)	(0.0239)	(0.0606)
Oil tankers (100,000s of tons)	0.0017***	0.0029***	-0.0014***	-0.0015***	0.0038***
	(0.0002)	(0.0003)	(0.0001)	(0.0001)	(0.0006)
Average time to ratify previous IEAs (days/365)	0.0508*	0.0636	-0.0318*	-0.0289*	0.0581
	(0.0269)	(0.0387)	(0.0189)	(0.0162)	(0.0371)
Total number of previous IEAs ratified	0.0455***	0.0669***	-0.0353***	-0.0357***	0.0704***
	(0.0081)	(0.0140)	(0.0057)	(0.0051)	(0.0147)
Land area (100,000s of sq.km)	0.0015	0.0072	-0.0018	-0.0032	0.0092
	(0.0071)	(0.0117)	(0.0039)	(0.0038)	(0.0103)
Coastline length (thousands of km)	0.0001	-0.0021	0.0007	0.0020	-0.0054
	(0.0041)	(0.0070)	(0.0030)	(0.0027)	(0.0067)
Latitude	-0.8749	-1.3007	0.5888	0.6339	-1.1747
	(0.6833)	(1.0443)	(0.4785)	(0.4345)	(0.9823)
Constant	-10.7100***	-12.8719***	9.9797***	9.9554***	
	(0.3770)	(0.6122)	(0.2430)	(0.2145)	
Shape parameter		0.0003***	-0.7221***	-1.3318***	
Log-likelihood	-139.5	-110.8	-93.5	-90.6	-393.9
AIC	310.9	255.5	221.0	215.2	817.8
BIC	356.7	304.2	269.6	263.8	860.7

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

B. Continuous Models With Time-Varying Covariates

Table B1. Determinants of MARPOL legislative delay - concurent quantity of oil spill specifications (period 1978-2009, n=2499)

	Exponential	Gompertz	Lognormal	Loglogistic	Cox	Discrete Time Proportional Hazards	Logit
Oil spill quantity (in 10,000s of tons)	2.1996	4.1245**	-2.1051**	-1.8068	0.2302	2.4010	2.4547
	(1.9781)	(1.9293)	(0.9453)	(1.1081)	(0.2267)	(2.1440)	(2.5553)
Square of oil spill quantity (in 10,000s of tons)	-2.53220	-4.28485**	2.24201**	2.11897*	-0.38908	-2.62998	-2.83026
	(1.81325)	(1.96681)	(0.88083)	(1.18786)	(0.30148)	(2.58968)	(2.71662)
Population (in millions)	0.0021***	0.0029***	-0.0011***	-0.0011***	0.0004***	0.0022**	0.0023**
	(0.0006)	(0.0011)	(0.0003)	(0.0002)	(0.0001)	(0.0011)	(0.0011)
PolityIV	0.0467***	0.0183	-0.0010	0.0008	0.0017*	0.0475***	0.0486***
	(0.0126)	(0.0176)	(0.0069)	(0.0065)	(0.0009)	(0.0179)	(0.0167)
Trade openness	0.0054***	0.0061***	-0.0022***	-0.0020***	0.0005***	0.0054***	0.0058***
	(0.0014)	(0.0019)	(0.0008)	(0.0007)	(0.0001)	(0.0019)	(0.0021)
GDP (in hundreds of billions of 1990$)	-0.0190	-0.0074	-0.0065	-0.0100	0.0042	-0.0198	-0.0165
	(0.0195)	(0.0274)	(0.0090)	(0.0075)	(0.0029)	(0.0404)	(0.0352)
Oil production (thousands of barrels)	0.1684***	0.0840	0.0075	0.0169	0.0050**	0.1725**	0.1760**
	(0.0407)	(0.0519)	(0.0216)	(0.0172)	(0.0021)	(0.0868)	(0.0879)
Oil tankers (100,000s of tons)	0.0019***	0.0036***	-0.0016***	-0.0017***	0.0008***	0.0020*	0.0021*
	(0.0003)	(0.0005)	(0.0001)	(0.0001)	(0.0001)	(0.0010)	(0.0011)
Average time to ratify previous IEAs (days/365)	0.0705**	0.0745*	-0.0340*	-0.0267	0.1040**	0.0715***	0.0732*
	(0.0283)	(0.0400)	(0.0205)	(0.0177)	(0.0412)	(0.0208)	(0.0420)
Total number of previous IEAs ratified	0.0451***	0.0788***	-0.0367***	-0.0376***	0.0718***	0.0467***	0.0497***
	(0.0069)	(0.0111)	(0.0049)	(0.0040)	(0.0120)	(0.0115)	(0.0116)
Land area (100,000s of sq.km)	-0.0027	0.0010	-0.0015	-0.0019	0.0045	-0.0032	-0.0029
	(0.0084)	(0.0135)	(0.0029)	(0.0030)	(0.0070)	(0.0118)	(0.0115)
Coastline length (thousands of km)	0.0019	0.0034	-0.0002	-0.0000	-0.0004	0.0020	0.0018
	(0.0039)	(0.0062)	(0.0018)	(0.0019)	(0.0040)	(0.0069)	(0.0069)
Latitude	-0.8631	-1.2049	0.6008	0.7608**	-0.7941	-0.8924	-0.9580
	(0.6678)	(0.9847)	(0.4481)	(0.3674)	(0.9132)	(1.0424)	(0.9997)
Constant	-5.2278***	-7.7019***	4.1418***	4.0511***		-5.2459	-5.3138***
	(0.3983)	(0.6254)	(0.2554)	(0.2271)		-0.0001	(0.5919)
Shape parameter		0.1185***	-0.7521***	-1.3834***			
Log-likelihood	-127.3	-96.1	-87.3	-84.0	-382.2	-384.5	-384.1
AIC	282.7	222.3	204.6	197.9	790.3	795.0	798.2
BIC	364.2	309.6	292.0	285.3	866.1	870.7	885.6

Table B2. Determinants of MARPOL legislative delay -concurrent oil spill incidents (period 1978-2009, n=2499)

	Exponential	Gompertz	Lognormal	Loglogistic	Cox	DTPH	Logit
Oil spill incidents (in tens)	-0.9628	-0.7127	0.2754	0.2211	0.1061	-1.0285***	-1.3101
	(0.7468)	(0.6236)	(0.3253)	(0.2910)	(0.1253)	(0.3775)	(0.8490)
Square of oil spill incidence (in tens)	0.0874	0.0617	-0.0025	0.0111	-0.0300	0.0962	0.1063
	(0.0999)	(0.0933)	(0.0658)	(0.0586)	(0.0291)	(0.1114)	(0.1296)
Population (in millions)	0.0020***	0.0029***	-0.0011***	-0.0010***	0.0004***	0.0021***	0.0021*
	(0.0006)	(0.0011)	(0.0003)	(0.0002)	(0.0001)	(0.0007)	(0.0011)
PolityIV	0.0483***	0.0233	-0.0016	0.0003	0.0017*	0.0491***	0.0504***
	(0.0128)	(0.0177)	(0.0071)	(0.0065)	(0.0009)	(0.0147)	(0.0167)
Trade openness	0.0055***	0.0061***	-0.0022***	-0.0020***	0.0004***	0.0057***	0.0060***
	(0.0014)	(0.0019)	(0.0008)	(0.0007)	(0.0001)	(0.0014)	(0.0021)
GDP (in hundreds of billions of 1990$)	0.0132	0.0279	-0.0273**	-0.0299***	0.0042	0.0138	0.0396
	(0.0235)	(0.0298)	(0.0108)	(0.0086)	(0.0072)	(0.0000)	(0.0470)
Oil production (thousands of barrels)	0.1960***	0.1125*	-0.0185	0.0003	0.0050**	0.2009***	0.2104**
	(0.0452)	(0.0579)	(0.0287)	(0.0206)	(0.0023)	(0.0666)	(0.0857)
Oil tankers (100,000s of tons)	0.0020***	0.0036***	-0.0016***	-0.0017***	0.0008***	0.0021**	0.0022**
	(0.0003)	(0.0004)	(0.0001)	(0.0001)	(0.0001)	(0.0009)	(0.0011)
Average time to ratify previous IEAs (days/365)	0.0675**	0.0718*	-0.0328	-0.0267	0.0999**	0.0678***	0.0708*
	(0.0289)	(0.0399)	(0.0211)	(0.0179)	(0.0399)	(0.0151)	(0.0422)
Total number of previous IEAs ratified	0.0436***	0.0720***	-0.0357***	-0.0366***	0.0722***	0.0456***	0.0483***
	(0.0075)	(0.0121)	(0.0054)	(0.0045)	(0.0114)	(0.0046)	(0.0114)
Land area (100,000s of sq.km)	-0.0033	0.0008	-0.0014	-0.0026	0.0029	-0.0038	-0.0024
	(0.0096)	(0.0143)	(0.0031)	(0.0027)	(0.0073)	(0.0062)	(0.0118)
Coastline length (thousands of km)	0.0019	0.0024	0.0002	0.0010	-0.0021	0.0022	0.0011
	(0.0045)	(0.0067)	(0.0025)	(0.0022)	(0.0049)	(0.0046)	(0.0070)
Latitude	-0.6895	-0.8375	0.5723	0.7106*	-0.8862	-0.7276	-0.7983
	(0.6908)	(0.9970)	(0.4757)	(0.3995)	(0.9018)	(0.4454)	(0.9840)
Constant	-5.2153***	-7.5309***	4.1174***	4.0519***		-5.2321***	-5.3192***
	(0.4022)	(0.6319)	(0.2641)	(0.2315)		(0.2020)	(0.5934)
Shape parameter		0.1133***	-0.7306***	-1.3665***			
Log-likelihood	-128.6	-99.4	-89.9	-86.5	-382.9	-385.9	-385.2
AIC	285.3	228.9	209.9	203.0	791.7	797.8	800.3
BIC	366.8	316.2	297.2	290.3	867.4	873.5	887.7

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table B3. Determinants of MARPOL legislative delay -concurrent oil spill quantity and incidents (period 1978-2009, n=2499)

	Exponential	Gompertz	Lognormal	Loglogistic	Cox	DTPH	Logit
Oil spill quantity (in 10,000s of tons)	3.4263*	5.2880**	-2.5243***	-2.1503**	0.0922	3.6424	3.9761
	(2.0822)	(2.1850)	(0.9397)	(1.0046)	(0.3444)	(2.2543)	(2.5390)
Square of oil spill quantity (in 10,000s of tons)	-3.1761*	-4.9559**	2.4546***	2.2388**	-0.2865	-2.62998	-3.6681
	(1.8355)	(2.0926)	(0.8106)	(0.8996)	(0.3770)	(2.58968)	(2.5773)
Oil spill incidents (in tens)	-1.4403*	-1.2541	0.4468	0.3264	0.1442	-1.5284*	-1.8438*
	(0.8663)	(0.8647)	(0.3944)	(0.3680)	(0.1839)	(0.9016)	(1.1052)
Square of oil spill incidence (in tens)	0.0021	0.0018	-0.0002	-0.0000	-0.0003	0.0022	0.0023
	(0.0015)	(0.0016)	(0.0008)	(0.0007)	(0.0004)	(0.0019)	(0.0022)
Population (in millions)	0.0021***	0.0029**	-0.0010***	-0.0009***	0.0004***	0.0022*	0.0022*
	(0.0007)	(0.0011)	(0.0003)	(0.0002)	(0.0001)	(0.0012)	(0.0011)
PolityIV	0.0476***	0.0202	-0.0013	0.0006	0.0016	0.0481***	0.0499***
	(0.0127)	(0.0176)	(0.0070)	(0.0065)	(0.0010)	(0.0164)	(0.0168)
Trade openness	0.0054***	0.0061***	-0.0023***	-0.0021***	0.0005***	0.0055***	0.0059***
	(0.0014)	(0.0018)	(0.0008)	(0.0007)	(0.0001)	(0.0019)	(0.0021)
GDP (in hundreds of billions of 1990$)	0.0047	0.0190	-0.0276***	-0.0301***	0.0025	0.0047	0.0323
	(0.0244)	(0.0316)	(0.0087)	(0.0077)	(0.0074)	(0.0355)	(0.0489)
Oil production (thousands of barrels)	0.1867***	0.0915*	-0.0023	0.0090	0.0049**	0.1916**	0.2005**
	(0.0426)	(0.0524)	(0.0221)	(0.0171)	(0.0023)	(0.0858)	(0.0891)
Oil tankers (100,000s of tons)	0.0021***	0.0037***	-0.0016***	-0.0016***	0.0008***	0.0022**	0.0023**
	(0.0003)	(0.0004)	(0.0001)	(0.0001)	(0.0001)	(0.0010)	(0.0011)
Average time to ratify previous IEAs (days/365)	0.0670**	0.0710*	-0.0345*	-0.0271	0.1084***	0.0676**	0.0704*
	(0.0287)	(0.0401)	(0.0207)	(0.0178)	(0.0415)	(0.0334)	(0.0424)
Total number of previous IEAs ratified	0.0477***	0.0792***	-0.0372***	-0.0382***	0.0735***	0.0503***	0.0526***
	(0.0073)	(0.0112)	(0.0050)	(0.0041)	(0.0114)	(0.0106)	(0.0119)
Land area (100,000s of sq.km)	-0.0045	-0.0005	-0.0019	-0.0025	0.0050	-0.0053	-0.0038
	(0.0101)	(0.0145)	(0.0028)	(0.0026)	(0.0068)	(0.0123)	(0.0119)
Coastline length (thousands of km)	0.0032	0.0042	0.0004	0.0008	-0.0016	0.0036	0.0025
	(0.0046)	(0.0067)	(0.0017)	(0.0017)	(0.0048)	(0.0071)	(0.0071)
Latitude	-0.8822	-1.1396	0.6075	0.7812**	-0.8616	-0.9476	-0.9885
	(0.6764)	(0.9841)	(0.4536)	(0.3657)	(0.9007)	(0.8533)	(1.0016)
Constant	-5.2287***	-7.6570***	4.1653***	4.0754***		-5.2530***	-5.3388***
	(0.3981)	(0.6227)	(0.2555)	(0.2269)		(0.4666)	(0.5938)
Shape parameter		0.1173***	-0.7502***	-1.3856***			
Log-likelihood	-125.6	-95.1	-86.4	-82.9	-381.8	-382.6	-381.9
AIC	283.3	224.2	206.7	199.8	793.5	799.1	797.8
BIC	376.5	323.2	305.7	298.8	880.9	898.1	896.8

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

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